

# Tank Farm Vadose Zone Contamination Volume Estimates

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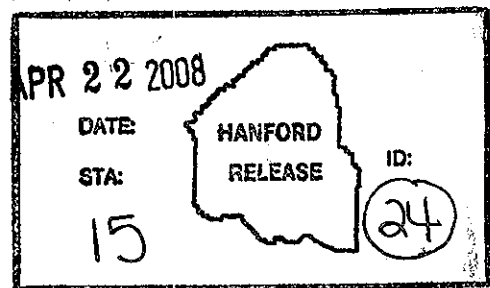
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**Abstract:** This report provides estimated vadose zone contamination volumes and dates for single-shell tank leaks and unplanned releases (UPRs) within designated Waste Management Areas (WMA) in the Hanford Site Tank Farms. The Washington State Department of Ecology (Ecology) and the Department of Energy Office of River Protection (ORP) have determined that the volume estimates presented in revision 2 of this report required further review. CH2M HILL Hanford Group Inc. has developed jointly with DOE-ORP and Ecology the protocol to re-assess selected tank leak estimates and to update tank leak and UPR volumes, and inventory estimates as emergent field data is obtained. Ecology has reviewed and agreed to this process. Historical tank leak estimates and UPRs in WMA C have been reviewed and incorporated into revision 3 of this document.

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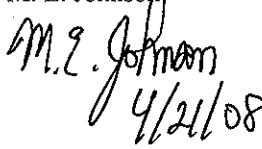
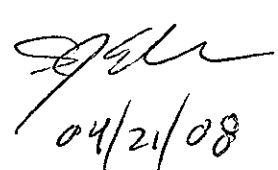
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# **TANK FARM VADOSE ZONE CONTAMINATION VOLUME ESTIMATES**

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**LIST OF TERMS****Acronyms and Abbreviations**

BBI	best-basis inventory
bgs	below ground surface
CMS	Corrective Measures Study
DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology
HDW	Hanford Defined Waste
HLW	high-level waste
LAW	low-activity waste
PNNL	Pacific Northwest National Laboratory
PSN	PUREX supernatant neutralized waste
PUREX	Plutonium-Uranium Extraction
R1	REDOX waste generated between 1952 and 1957
RCRA	Resource Conservation and Recovery Act of 1976
REDOX	reduction and oxidation
RFI	RCRA Facility Investigations
SIM	Soil Inventory Model
SST	single-shell tank
SST PA	Single-Shell Tank Performance Assessment
TBP	tributyl phosphate
TWINS	<i>Tank Waste Information Network System</i>
UPR	unplanned release
WIDS	<i>Waste Information Data System</i>
WMA	Waste Management Area

**Units**

Ci	curies
cc	cubic centimeters
cpm	counts per minute
°F	degrees Fahrenheit
ft	feet
ft <sup>2</sup>	square feet
ft <sup>3</sup>	cubic feet
g	grams
gal	gallons
h	hour
in.	inch(es)
kgal	thousand gallons
L	liter
m	meters
m <sup>3</sup>	cubic meters
Mgal	million gallons
pCi	picocuries
wk	week

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## 1.0 INTRODUCTION

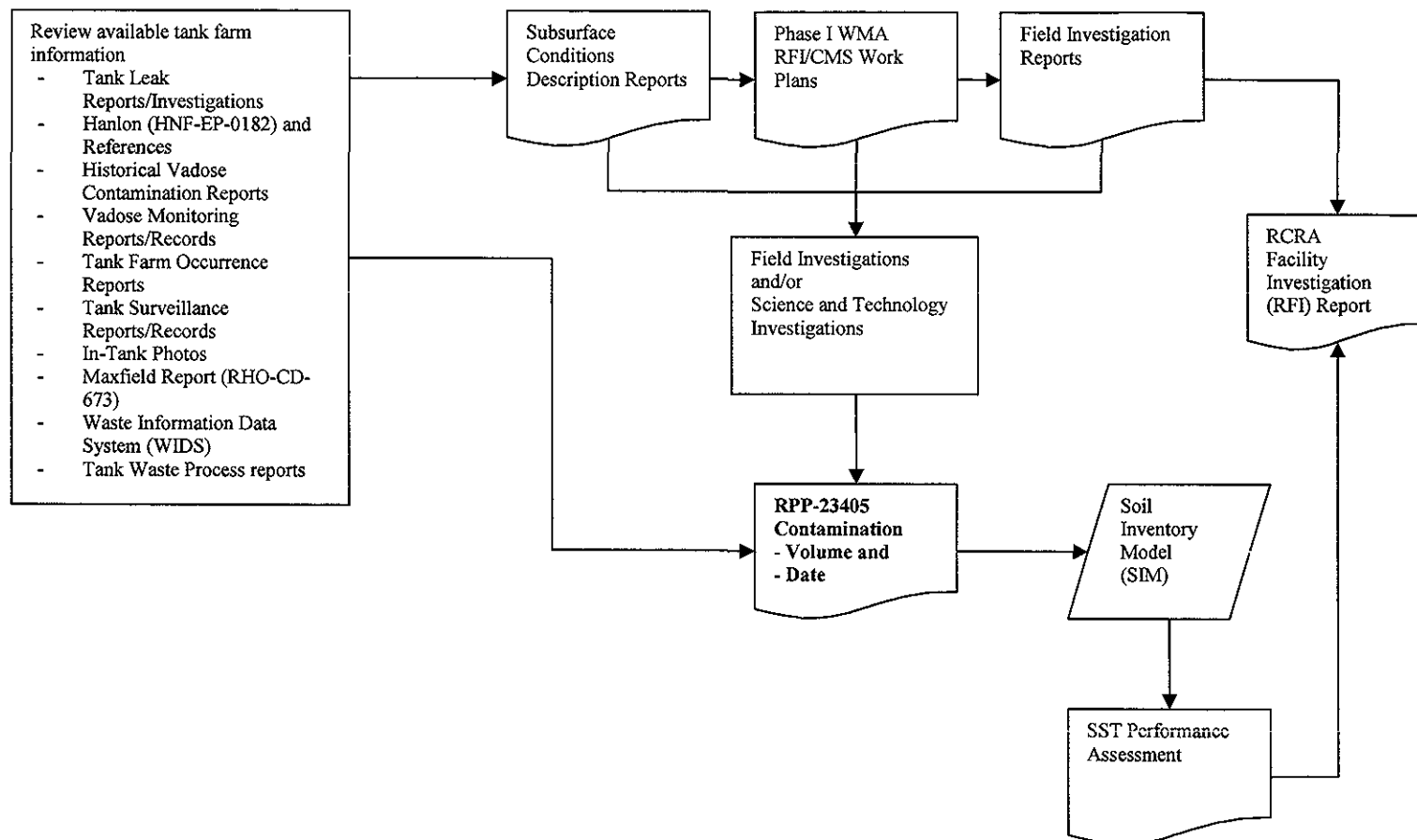
This report provides estimated vadose zone contamination volumes and dates for single-shell tank (SST) leaks and Unplanned Releases (UPRs) within designated Waste Management Areas (WMA) in the Hanford Site Tank Farms. The volumes presented incorporate leak volume estimates from previous evaluations and proposed leak volume estimates from investigations conducted by the Hanford Site Tank Farm Vadose Zone Team. Volume estimates and tank waste composition dates in revision 2 of this report were inputs to the Hanford Site Wide Soil Inventory Model (SIM) (RPP-26744, *Hanford Soil Inventory Model*, Rev. 1) and were used to calculate vadose zone contamination inventories. This was done to support the information needs for the Initial SST Performance Assessment (SST PA) (DOE/ORP-2005-01). The Washington State Department of Ecology (Ecology) and the Department of Energy Office of River Protection (ORP) have determined that the volume estimates presented in this report require further review as well as the need to establish the uncertainties associated with both the volume and composition estimates. Tank leak volume and UPR estimates and the resulting waste compositions will be reassessed and updated in accordance with a protocol document being developed with Ecology (Schepens 2006).

CH2M HILL Hanford Group Inc. has developed jointly with DOE-ORP and Ecology the protocol to re-assess selected tank leak estimates and to update tank leak and UPR volumes, and inventory estimates as emergent field data is obtained (RPP-32681, 2007, *Process to Estimate Tank Farm Vadose Zone Inventories*). Ecology has reviewed and agreed to this process (Lyon 2008). Historical tank leak estimates and UPRs in waste management area (WMA) C have been reviewed using this process (RPP-ENV-33418, rev. 1) and tank leak and UPR estimates for WMA C have been updated in revision 3 of this document. Tank Farm vadose zone investigations are ongoing through the Resource Conservation and Recovery Act Facility Investigations and Corrective Measures studies (RFI/CMS) process. As additional field characterization data are obtained and additional WMAs are assessed using the process described in RPP-32681, tank leak volumes and compositions will be revised.

Surface contamination volume estimates in this report are based only on the UPRs included within a WMA in the Waste Information Data System (WIDS). The Tank Farm Vadose Zone Team has only started to evaluate surface contamination.

Figure 1-1 illustrates the basis for reference case vadose zone contamination volume estimates and the role of this report.

Figure 1-1. Basis for RPP-23405 and Role in Developing the RFI Report.



## 1.1 BACKGROUND

A major focus of the Hanford Site Tank Farm Vadose Zone program is to better understand and quantify vadose zone contamination in and around the SSTs. Vadose zone program activities include:

- Spectral gamma logging of all available drywells in the SST farms
- Analysis of historical gross gamma logging data collected from 1974 through 1994 in the SST farms
- Review of available historical Tank Farm operational records, surveillance records, tank leak documentation, and field characterization data from a number of the SST farms
- Science and Technology investigations that enhance the understanding of the interactions between tank waste materials and Hanford Site soils.

The Hanford Site Tank Farm Vadose Zone program is managed by CH2M HILL Hanford Group, Inc. (CH2M HILL) under the direction of the U.S. Department of Energy (DOE) Office of River Protection and functions through a multi-contractor multi-disciplined approach. Tank Farm vadose zone activities are integrated with other subsurface characterization efforts through the DOE Groundwater Protection Program managed by Fluor Hanford. The reference case leak volume estimates presented in this report were based largely on the following vadose zone program documents:

- HNF-4936, *Subsurface Conditions Description of the S and SX Waste Management Area*
- HNF-5507, *Subsurface Conditions Description of the B-BX-BY Waste Management Area*
- RPP-6285, *Inventory Estimates for Single-Shell Tank Leaks in S and SX Tank Farms*
- RPP-7123, *Subsurface Conditions Description of the T-TX-TY Waste Management Area*
- RPP-7218, *Preliminary Inventory Estimates for Single-Shell Tank Leaks in T, TX, and TY Tank Farms*
- RPP-7389, *Preliminary Inventory Estimates for Single-Shell Tank Leaks in B, BX, and BY Tank Farms*
- RPP-14430, *Subsurface Conditions Description of the C and A-AX Waste Management Area*
- RPP-15808, *Subsurface Conditions Description of the U Waste Management Areas*
- RPP-ENV-33418, *Hanford C-Farm Leak Assessments Report: 241-C-101, 241-C-110, 241-C-111, 241-C-105, and Unplanned Waste Releases.*

## 1.2 SCOPE

Two groups of soil contamination volume estimates presented in this report are: (1) tank/ancillary equipment leak volumes, and (2) volume of UPRs or surface contamination within the SST farms.

This report includes reference case tank leak volumes for the 67 SSTs classified as assumed leakers in HNF-EP-0182, *Waste Tank Summary Report for Month Ending March 31, 2005*. All of the 82 SSTs classified in HNF-EP-0182 as “sound” were also assessed by the vadose team. A recent assessment of historical waste loss events is the 241-C Tank Farm, RPP-ENV-33418, *Hanford C-Farm Leak Assessments Report: 241-C-101, 241-C-110, 241-C-111, 241-C-105, and Unplanned Waste Releases*, was utilized to estimate reference leak volumes for the subject tanks in 241-C Tank Farm. Any changes to the classification of tanks 241-C-105, 241-C-110, or 241-C-111 will be based on a formal tank leak status assessment process that is planned to be conducted by September 30, 2008 (Olinger 2008).

In addition to tank leaks or spills from tanks/ancillary equipment, another source of contamination in the tank farm is UPRs. The UPR estimates shown in this report are those reported in WIDS as of July 1, 2005. Because UPRs were assumed to have a much smaller inventory compared to tank leaks, except for C Tank Farm studies, the vadose program has done little work to quantify or validate current UPR estimates. Near-surface contamination information and needs will be addressed in the RFI. This report and vadose inventory estimates will be updated as additional information is obtained.

Note: ancillary equipment are defined in this document as equipment or structures such as cascade lines, transfer lines, or pump pits connected to or directly associated with an SST that may be attributed to a tank leak (e.g., cascade lines, transfer lines, pump pits).

Sections 2.0 and 3.0 focus on assumed or confirmed leaking tanks (HNF-EP-0182) in the SST farms. Tank leaks are a major source of vadose zone contamination in the tank farms and have been the focus of vadose zone contamination studies. Section 2.0 provides tables showing leak volume estimates from the tanks or ancillary tank equipment assumed to contribute to the vadose zone inventory. A synopsis describing the basis for tank or ancillary equipment leak volume estimates is presented in Section 3.0. More detailed discussions are presented in reports referenced. For some tanks, little or no basis for previous leak volume estimates was found; however, some tank leak events and volume estimates are well documented. Tank leak estimates were grouped as:

- Group 1 – Well known and documented leak volumes that increased or remained the same based on vadose zone investigations. Although the existence of a contamination plume is well documented for tanks in this group, leak volume estimates are highly uncertain for some of these tanks.
- Group 2 - No basis for change from previous leak volume estimates. Leak volume estimates cannot be confirmed or refuted based on available vadose data.
- Group 3 – Vadose data or assessment report data appear to be inconsistent with previous leak volume estimates for these tanks, and reference case leak volumes are

lower than previous estimates. As for Group 1, leak volume estimates are highly uncertain for some of these tanks.

- Group 4 - No record of a liquid level decrease and little or no basis for reference case leak volume estimates.

The following items were not addressed:

- Tank/ancillary equipment leak volumes do not include tank waste residuals or residuals in pipelines or ancillary equipment.
- While tank leak volume estimates were revised for some of the tanks and no inventory basis was found for others, previous tank integrity classifications were not changed. Change to tank integrity classifications requires implementing the tank leak assessment process (TFC-ENG-CHEM-D-42, "Tank Leak Assessment Process") and is beyond the scope of this report.
- Crib and trench discharges are mostly outside Tank Farm WMA boundaries and are not discussed in this report. Crib and trench discharges will be addressed in future Hanford Site integration studies.

A list of documented UPR and near-surface contamination volume estimates in the SST farms is presented in Section 4.0. The near-surface losses presented in this report are UPRs included in WIDS as of July 1, 2005. Although extensive surface contamination is found in some farms, the volume of waste from UPRs generally is a small fraction of the total volume from tank leaks and ancillary equipment.

### 1.3 PROCESS

The Waste Tank Summary Report (HNF-EP-0182) presents leak volumes for SSTs designated "confirmed or suspected leakers." The need for tank leak inventory estimates was identified early on in the process of developing data requirements for characterizing environmental impacts of single-shell tank leaks, (HNF-2603, *A Summary and Evaluation of Hanford Site Tank Farm Subsurface Contamination*). The Hanford Defined Waste Model (RPP-19822, *Hanford Defined Waste Model – Revision 5*) provided an approach to estimate SST leak inventories. The Hanford Defined Waste (HDW) Model provided an estimate of waste compositions in each Hanford Site single- and double-shell waste storage tank as a function of time. Such data could then be coupled with dates of known tank leaks and leak volumes to develop approximations of chemicals and radionuclides lost during a leak event. This process is shown schematically in Figure 1-2.

A major assumption in developing leak inventory estimates is that the HDW Model, which couples chemical processing flow sheet data with waste transfer records to estimate tank waste compositions over time, provides a reasonable waste composition at the time of waste loss events. Although there are a number of limitations and uncertainties in the HDW model composition estimates, the HDW model provides the only source of information to estimate tank waste composition at the time of a leak.

As stated in the introduction, composition and inventory estimates are not provided in this report. Volume estimates and tank waste composition dates in this document are inputs to the Hanford Site Wide Soil Inventory Model (SIM) which calculates vadose zone contaminant inventories. The SIM multiplies the contaminant volume for a waste-loss event by an estimated waste composition at the time of the event to derive an inventory. The SST WMA contaminant concentrations in SIM are from HDW Model estimates (RPP-19822). The HDW Model uses a mass balance and mixing model to estimate waste composition by tank and year. Inventories for reference case leak volume estimates are documented in RPP-26744, but require update due to the new estimates for WMA C tank leaks provided in revision 3 of this document.

Even more problematic were the estimates of the "leak date" and "leak volume." The Waste Tank Summary Report (HNF-EP-0182) provides the date on which a tank was determined to be an "assumed or confirmed" leaker and an estimated leak volume. However, in many cases, the leak date shown in HNF-EP-0182 is considerably different from the likely date a leak occurred. The basis for some of the leak volume estimates presented in HNF-EP-0182 was also unclear. The vadose team reviewed references provided in HNF-EP-0182 and, in some cases, found the information to be incomplete or found technical discrepancies in the evaluations. Consequently, all available information on SST leaks was reevaluated. This reevaluation examined available tank integrity information for each of the 149 SSTs. The major effort in the 1990s to declassify and release to the public large numbers of Hanford Site historical documents greatly facilitated the reevaluation of SST leaks, as did the completion of a systematic re-logging of SST farm drywells using spectral gamma techniques.

The goal was to correlate historical estimates of SST leaks with information from other sources. For example, the loss of large volumes of high-activity waste would be expected in most cases to lead to significant residual cesium-137 ( $^{137}\text{Cs}$ ) contamination in the soil<sup>1</sup>. Lack of such  $^{137}\text{Cs}$  contamination led to careful reassessment of historical data supporting the original assignment of a leak volume. Results of these assessments are documented primarily in the Subsurface Conditions Reports (SCDRs). Several variations of this information were presented in subsequent vadose reports and evaluations, the most recent being the T-TX-TY Field Investigation Report. Each of these reports built on the previous information. Leak volume updates and changes from one report to the next were based on new characterization information and/or results of new documentation. Better estimates for tank leak volumes and vadose contamination continue to be developed through the RFI process and the process described in RPP-32681.

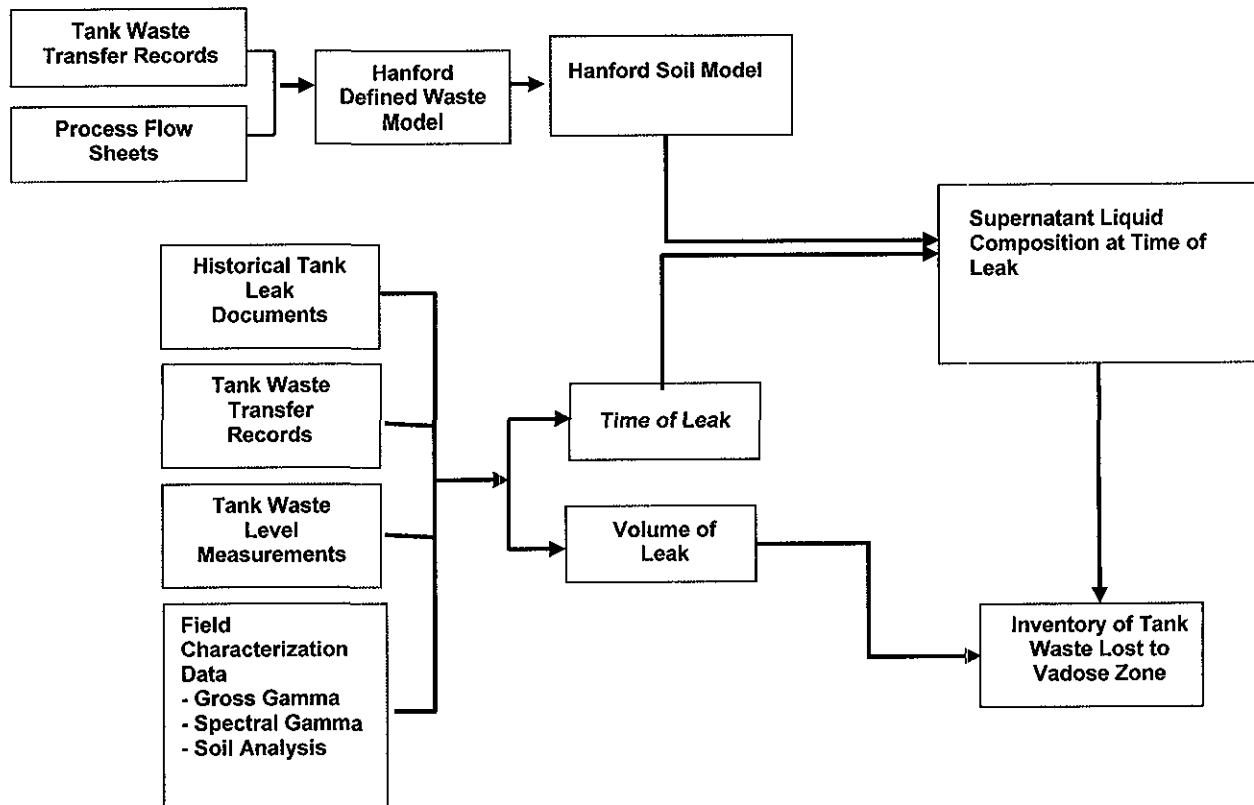
Near-surface contamination volumes presented in Section 4.0 were a compilation of UPRs included in the WIDS database as of July 2005 and located within designated WMAs. Volumes shown were those specified in the WIDS or derived based on information in WIDS. Waste compositions for tanks and UPRs and inventory calculations will be presented in the SIM report.

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<sup>1</sup> A few of the waste types generated at the Hanford site do not include significant concentrations of  $^{137}\text{Cs}$ . For example, the major radionuclides contained in waste generated at the 201-C Strontium Semiworks from 1960 to 1967 were  $^{90}\text{Sr}/^{90}\text{Y}$ ,  $^{144}\text{Ce}/^{144}\text{Pm}$ , and  $^{147}\text{Pm}$ . Since both  $^{144}\text{Ce}/^{144}\text{Pm}$ , and  $^{147}\text{Pm}$  have half-lives of about 284 days and 2.6 years respectively, these radionuclides are no longer readily detected in this waste.

Many of the UPRs were airborne particulate releases or were assumed to be low volume sprays. There was no technical basis for a volume estimate for these UPRs, and no volume estimates were presented in the WIDS. Therefore, the inventories for these UPRs were assumed to be negligible and are not included. Other than work in C Tank Farm, there has been little effort in addition to the data presented in WIDS to further characterize or quantify surface contamination within the Tank Farms. As for tank leaks, the UPR estimates presented in this report will be updated as sites are further characterized and as new information is obtained. Characterization plans are or will be identified in RFI Phase 1 documents.

Figure 1-2. Historical Tank Leak Inventory Estimates Flow Chart.



## 2.0 TANK/ANCILLARY EQUIPMENT LEAK ESTIMATES IN SINGLE-SHELL TANK FARMS

Sixty-seven of the Hanford Site's 149 SSTs are listed as "confirmed or assumed leakers" in HNF-EP-0182. Much of the tank leak information in HNF-EP-0182 was compiled in the late 1980s and reflects the state of knowledge at that point in time. Leak volume estimates are of varying quality; for example, the leak volumes for SSTs SX-113, SX-115, and T-106 are well documented; however, 19 tanks have unexplained liquid-level decreases and no technical basis for a leak volume or inventory estimate.

Some of the tank leaks listed in HNF-EP-0182 (Rev. 199) may be associated with waste transfer system waste-loss events and tank overflow events and appear to be associated with ancillary equipment rather than failure of the tank itself. These events are described in RPP-6285; RPP-7218; RPP-7389; RPP-7884, *Field Investigation Report for Waste Management Area S-SX*; RPP-10098, *Field Investigation Report for Waste Management Area B/BX/BY*; RPP-15808, RPP-ENV-33418, and summarized in Section 3.0.

Over the past decade, vadose investigations have focused on developing a better understanding of major SST leaks and the potential impacts of SST leaks on groundwater quality by reviewing vadose and tank process data for each of the 149 SSTs. The vadose zone team efforts focused on defining the impacts of "Tank Farm operations" on the vadose zone, including past leaks from SSTs, SST overfills, and piping and infrastructure waste-loss events.

The vadose zone characterization effort included field drilling, sampling, and soil analysis in multiple SST farms coupled with research and review of historical process records and gamma logging data. These efforts integrated information from a number of Hanford-related projects and focused on evaluating the tank leak events that contribute the bulk of subsurface contamination. The following sources were reviewed for this report:

- Spectral gamma logging data from drywells
- Analysis of historical gross gamma logging data collected from 1974 through 1994
- Review of historical Tank Farm operations and surveillance records
- Review of historical process chemistry records from Hanford Site facilities
- Results from vadose zone characterization in WMA S/SX
- Studies of cesium sorption chemistry in Hanford Site soils
- Studies of moisture movement and unsaturated flow characteristics in Hanford Site soils.



## 2.1 GROSS GAMMA AND SPECTRAL GAMMA LOGGING DATA

Baseline spectral gamma logging has been completed for all of the drywells within each of the 12 SST farms as well as assessments of the historical gross gamma logging data from each SST farm. Results of the baseline spectral gamma logging project are summarized in 12 Grand Junction Office (GJO) Department of Energy spectral gamma logging tank farm reports (one for each SST farm). Analysis and summaries of the gross gamma logging data also are reported by tank farm. The spectral gamma logging tank farm reports are listed in Table 2-1.

Table 2-1. Spectral Gamma Logging  
Tank Farm Reports. (2 sheets)

Report	Title
GJO-HAN-6/GJO-96-2-TAR	<i>Vadose Zone Characterization Project at the Hanford Tank Farms, BY Tank Farm Report</i>
GJO-HAN-8/GJO-97-1-TAR	<i>Vadose Zone Characterization Project at the Hanford Tank Farms, U Tank Farm Report</i>
GJO-HAN-11/GJO-97-13-TARA	<i>Hanford Tank Farms Vadose Zone, TX Tank Farm Report</i>
GJO-HAN-12/GJO-97-14-TARA	<i>Addendum to the AX Tank Farm Report</i>
GJO-HAN-16/GJO-97-30-TAR	<i>Hanford Tank Farms Vadose Zone: TY Tank Farm Report</i>
GJO-HAN-18/GJO-98-39-TARA	<i>Hanford Tank Farms Vadose Zone: C Tank Farm Report</i>
GJO-HAN-19/GJO-98-40-TAR	<i>Hanford Tank Farms Vadose Zone: BX Tank Farm Report</i>
GJO-HAN-23/GJO-98-64-TAR	<i>Hanford Tank Farms Vadose Zone: A Tank Farm Report</i>
GJO-HAN-27/GJO-99-101-TARA	<i>Hanford Tank Farms Vadose Zone: T Tank Farm Report</i>
GJO-HAN-28/GJO-99-113-TAR	<i>Hanford Tank Farms Vadose Zone: B Tank Farm Report</i>
GJO-HAN-17/GJO-97-31-TAR	<i>Hanford Tank Farms Vadose Zone: S Tank Farm Report</i>
GJPO-HAN-4/DOE/ID/12584-268	<i>Vadose Zone Characterization Project at the Hanford Tank Farms, SX Tank Farm Report</i>
RPP-8820, Rev. 0	<i>Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-A Tank Farm – 200 East</i>
RPP-8821, Rev. 0	<i>Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-AX Tank Farm – 200 East</i>
HNF-5433, Rev. 0	<i>Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-B Tank Farm – 200 East</i>
HNF-3531, Rev. 0	<i>Analysis of Historical Gross Gamma Logging Data from BX Tank Farm</i>
HNF-3532, Rev. 0	<i>Analysis of Historical Gross Gamma Logging from BY Tank Farm</i>
RPP-8321, Rev. 0	<i>Analysis and Summary Report of Historical Dry Well Gamma Logging Logs for the 241-C Tank Farm – 200 East Area</i>
HNF-4220, Rev. 0	<i>Analysis and Summary of Historical Dry Well Gamma Logs for S Tank Farm – 200 West</i>

Table 2-1. Spectral Gamma Logging  
Tank Farm Reports. (2 sheets)

Report	Title
HNF-3136, Rev. 0	<i>Analysis Techniques and Monitoring Results, 241-SX Drywell Surveillance Logs</i>
RPP-6088, Rev. 0	<i>Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-T Tank Farm – 200 West</i>
RPP-6353, Rev. 0	<i>Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-TX Tank Farm – 200 West</i>
HNF-3831, Rev. 0	<i>Analysis of Historical Gross Gamma Logging Data from 241-TY Tank Farm</i>
RPP-7729, Rev. 0	<i>Analysis and Summary Report of Historical Dry Well Gamma Logging Logs for the 241-U Tank Farm – 200 West Area</i>

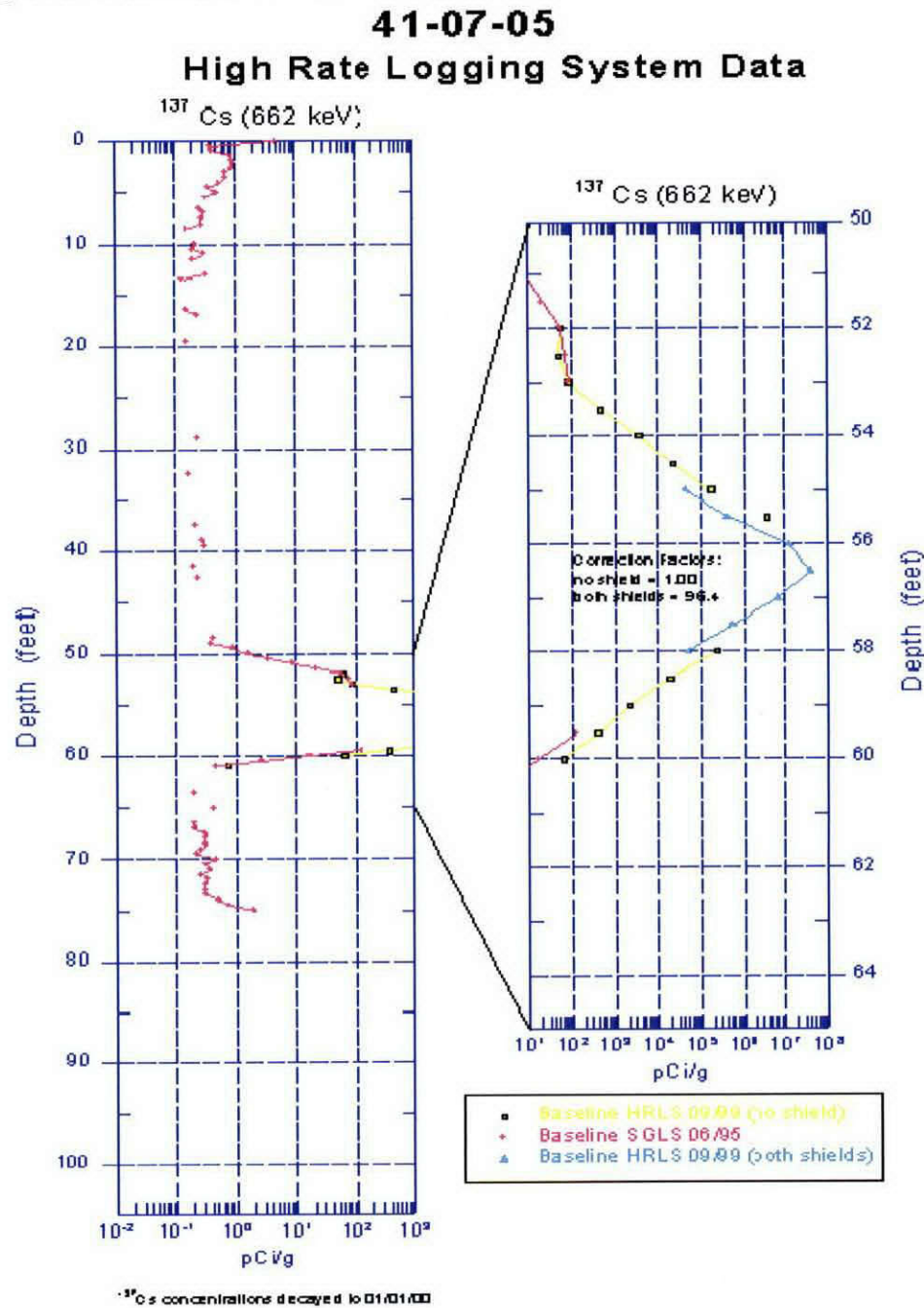
## 2.2 SINGLE-SHELL TANK FARM FIELD INVESTIGATIONS

HNF-2603 provides the technical basis for the Tank Farm vadose investigations. Since the publication of HNF-2603, additional technical documents have been released that track progress in the Tank Farm vadose characterization efforts (RPP-7884 and RPP-10098). A RCRA Facility Investigation Report for the Hanford Single-Shell Tank Waste Management Areas was also completed and includes field investigations in the C, A, AX, and U tank farms (DOE/ORP-2008-01). Washington State Department of Ecology is reviewing DOE/ORP-2008-01.

## 2.3 RELATIONSHIP BETWEEN LOGGING DATA AND TANK LEAKS

The baseline spectral gamma logging data collected from drywells within the SST farms provide a window for interpreting tank leak information. The relationship between the leak status of SSTs and spectral gamma logging data in nearby drywells is qualitative. However, both the depth of gamma activity and its intensity provide some ability to distinguish between tank losses and losses associated with piping or tank overfills and provides a basis to assess the impact of tank liquid-level decreases to the vadose zone.

Most easily distinguished are cases where waste volume decreases correspond to high  $^{137}\text{Cs}$  activity in one or more nearby drywells. In these cases,  $^{137}\text{Cs}$  activity is often greater than  $10^7$  pCi/g (Figure 2-1). Depending on the waste type present, there are frequently other gamma emitters at much lower concentrations. If the high  $^{137}\text{Cs}$  activity zones appear at or near the levels of the waste transfer lines or SST spare inlet ports, then this may be evidence of a piping leak or tank overfill event as the origin of the contamination. High  $^{137}\text{Cs}$  activity near the base of the tank is a strong indication of a tank leak. Lower cesium activity further away from a tank is much more difficult to interpret.

Figure 2-1. Example of  $^{137}\text{Cs}$  Activity for a Tank Leak in SX Tank Farm.

Low levels of  $^{137}\text{Cs}$  contamination are common in drywells around most SSTs. Open boreholes may have provided a pathway for contamination to enter the well casing, and in some cases, the unsealed boreholes could have provided a pathway for contamination to move downward. In addition, the compacted base on the original tank farm excavation provided a region for liquids to pond and move laterally. The cesium-sorption chemistry predicts that the  $^{137}\text{Cs}$  is in a highly concentrated plume with sharp activity drops at the edge of the plume (RPP-7884). Thus, when low  $^{137}\text{Cs}$  activity is reported in one of the drywells, it appears there are only two reasonable

explanations: (1) Either the drywell is sitting on the edge of a high-activity  $^{137}\text{Cs}$  plume, or (2) the contamination was the result of a lower activity gamma contamination spread from routine operations. Distinguishing between the two options requires an assessment of other information such as waste transfer and waste level records, waste type in the tank, documented leak history, and data from nearby drywells.

An understanding of the waste type involved in any type of release to the soil column is critical in developing a useful inventory estimate. Within reason, the type of waste lost is more important than the volume of waste lost. The  $^{137}\text{Cs}$  concentration was as high as 30 Ci/gal in the Plutonium-Uranium Extraction (PUREX) high-level waste (HLW) stream (ISO-100, *Waste Management Technical Manual*). For comparison, the waste stream generated from the dissolution of the aluminum cladding from the irradiated fuel rods carried about 0.003 Ci/gal of  $^{137}\text{Cs}$  (LA-UR-96-3860). Thus, a 1,000 gal loss of cladding waste would release approximately 3 Ci of  $^{137}\text{Cs}$ , whereas a 1,000 gal loss of a typical PUREX HLW could release as much as  $3 \times 10^4$  Ci of  $^{137}\text{Cs}$ .

## 2.4 REFERENCE CASE TANK/ANCILLARY EQUIPMENT LEAK VOLUME ESTIMATES

The tank/ancillary equipment reference case leak volumes were developed based on investigation and review of past tank data. Some volume estimates include losses from overfills, transfer line leaks, or cascade line leaks and are not necessarily attributed to a tank leak. Table 2-2 shows a comparison of the SST leak volumes reported in HNF-EP-0182 as of January 31, 2008 and reference case leak volumes developed in this report. The volumes in this report represent a "preliminary estimate" of the amount of contaminated waste in the vadose zone and do not reflect uncertainties or upper bounds in the data. As discussed in Section 3.0 for specific tanks, previous leak volume estimates (e.g., some estimates in HNF-EP-0182) appear to be inconsistent with vadose data. Based on newer data and investigations, some previous estimates, especially upper ranges, appear to be overly conservative. Efforts to reconcile inconsistencies are ongoing. The effect of uncertainties in the reference case estimates will be addressed in sensitivity studies in the SST PA.

As previously noted, the quality of tank/ancillary equipment leak estimates varies significantly. Some leaks are large with high-activity levels and have a strong documented technical basis. Others are "assumed" or "questionable" and little or no data is available to estimate a leak inventory or date. Tank/ancillary equipment leak estimates within the SST farms have been grouped into four categories defined in Section 1.2.

Table 2-2 identifies leak volume estimates for 68 SSTs and shows the following comparisons with previous estimates reported in HNF-EP-0182:

- 33 leak volume estimates were unchanged
- 7 leak volume estimates increased
- 9 leak volume estimates decreased (includes three BY Tank Farm tanks and C-111)
- 1 new estimate was added (C-105)

- 18 tanks had no technical basis for a leak volume estimate and were assumed negligible.

The technical basis for leak volume estimates for each of the tanks/ancillary equipment and/or tank groupings is presented in Section 3.0.

The “waste composition year” shown in Table 2-2 is the year SIM uses as the HDW model waste composition for a tank at the time of a leak. In general, the “waste composition year” is just after the last waste transfer into a tank prior to an estimated leak date or when the Waste Status Transfer Records indicate an unexplained liquid level decrease. When in doubt, a year was selected in which a tank had a conservatively high waste composition (i.e., high radioactivity). The years are not when the tank was declared a leaker (as shown in HNF-EP-0182) and not necessarily when a leak was assumed to occur (see Section 3.0).

Table 2-2. Reference Case Tank Leak Volume Estimates. (4 sheets)

Tank/Ancillary Equipment	UPR	HNF-EP-0182 (January 2008) leak volume (gal)	Reference Case Leak Volume (gal)	Waste Composition Year <sup>4</sup>	Group <sup>2</sup>
A-103	NA	5,500	5,500	1987	2
A-104	UPR-200-E-125	500 to 2,500	2,000	1975	2
A-105	UPR-200-E-126	10,000 to 270,000	1,000	1965	3
AX-102	NA	3,000	3,000	1975	2
AX-104	NA	---- <sup>1</sup>	No basis for estimate		4
B-101	NA	---- <sup>1</sup>	No basis for estimate		4
B-103	NA	---- <sup>1</sup>	No basis for estimate		4
B-105	NA	---- <sup>1</sup>	No basis for estimate		4
B-107	UPR-200-E-127	8,000	14,000	1965	1
B-110	UPR-200-E-128	10,000	10,000	1969	2
B-111	NA	---- <sup>1</sup>	No basis for estimate		4
B-112	NA	2,000	2,000		2
B-201	UPR-200-E-129	1,200	1,200	1965	2
B-203	UPR-200-E-130	300	300	1965	2
B-204	NA	400	400	1965	2
BX-101	UPR-200-E-131	---- <sup>1</sup>	4,000	1972	1
BX-102	UPR-200-E-132 UPR-200-E-5	70,000	91,600	1951	1
BX-108	UPR-200-E-133	2,500	2,500	1972	2
BX-110	NA	---- <sup>1</sup>	No basis for estimate		4
BX-111	NA	---- <sup>1</sup>	No basis for estimate		4
BY-103	UPR-200-E-134	<5,000	See <sup>3</sup>	1973	3
BY-105	NA	---- <sup>1</sup>	No basis for estimate		4

Table 2-2. Reference Case Tank Leak Volume Estimates. (4 sheets)

Tank/Ancillary Equipment	UPR	HNF-EP-0182 (January 2008) leak volume (gal)	Reference Case Leak Volume (gal)	Waste Composition Year <sup>4</sup>	Group <sup>2</sup>
BY-106	NA	---- <sup>1</sup>	No basis for estimate		4
BY-107	NA	15,100	See <sup>3</sup>	1974	3
BY-108	UPR-200-E-135	<5,000	See <sup>3</sup>	1972	3
C-101 <sup>(5)</sup>	UPR-200-E-136	20,000	20,000	1968	2
C-105 <sup>(5)</sup>	NA	Not Listed	40 to 2,000	1972	1
C-110 <sup>(5,6)</sup>	NA	2,000	<2,000	1971	2
C-111 <sup>(5)</sup>	NA	5,500	0	1968	3
C-201	NA	550	550	1965	2
C-202	NA	450	450	1965	2
C-203	UPR-200-E-137	400	400	1957	2
C-204	NA	350	350	1957	2
S-104	NA	24,000	24,000	1965	1
SX-104	NA	6,000	6,000	1988	2
SX-107	UPR-200-W-140	<5,000	15,000	1963	1
SX-108	UPR-200-W-141	2,400 – 35,000	35,000	1966	1
SX-109	UPR-200-W-142	<10,000	2,000	1966	1
SX-110	NA	5,500	1,000	1976	3
SX-111	UPR-200-W-143	500 - 2,000	500	1974	2
SX-112	UPR-200-W-144	30,000	1,000	1968	3
SX-113	UPR-200-W-145	15,000	15,000	1958	1
SX-114	NA	---- <sup>1</sup>	No basis for estimate		4
SX-115	UPR-200-W-146	50,000	50,000	1965	1
T-101	NA	7,500	10,000	1969	1
T-103	UPR-200-W-147	<1,000	3,000	1973	1
T-106	UPR-200-W-148	115,000	115,000	1973	1
T-107	NA	---- <sup>1</sup>	No basis for estimate		4
T-108	NA	<1,000	1,000	1974	2
T-109	NA	<1,000	1,000	1974	2
T-111	NA	<1,000	1,000	1971, 1994	2
TX-105	NA	---- <sup>1</sup>	No basis for estimate		4
TX-107	UPR-200-W-149	2,500	8,000	1977	1
TX-110	NA	---- <sup>1</sup>	No basis for estimate		4
TX-113	NA	---- <sup>1</sup>	No basis for estimate		4
TX-114	NA	---- <sup>1</sup>	No basis for estimate		4
TX-115	NA	---- <sup>1</sup>	No basis for estimate		4

Table 2-2. Reference Case Tank Leak Volume Estimates. (4 sheets)

Tank/Ancillary Equipment	UPR	HNF-EP-0182 (January 2008) leak volume (gal)	Reference Case Leak Volume (gal)	Waste Composition Year <sup>4</sup>	Group <sup>2</sup>
TX-116	NA	---- <sup>1</sup>	No basis for estimate		4
TX-117	NA	---- <sup>1</sup>	No basis for estimate		4
TY-101	NA	<1,000	1,000	1973	2
TY-103	UPR-200-W-150	3,000	3,000	1971	1
TY-104	UPR-200-W-151	1,400	1,400	1981	2
TY-105	UPR-200-W-152	35,000	35,000	1957	1
TY-106	UPR-200-W-153	20,000	20,000	1959	1
U-101	UPR-200-W-154	30,000	5,000	1959	3
U-104	UPR-200-W-155	55,000	55,000	1956	1
U-110	UPR-200-W-156	5,000 – 8,100	6,500	1975	1
U-112	UPR-200-W-157	8,500	8,500	1967	1

## Notes:

<sup>1</sup> The leak volume estimates in HNF-EP-0182 for these tanks were based on an assumption that their cumulative leakage is approximately the same as for 18 of the 24 tanks where leak volumes were determined by liquid-level decreases. SSTs SX-110 and T-106 were considered atypical and were not included. SSTs B-201, -203, -204, and C-203, also excluded, are small 200-series diameter tanks. The 18 tank leak estimates that were included in the estimate were SSTs A-103, AX-102, B-107, B-110, BY-107, C-101, C-111, S-104, SX-104, SX-109, T-103, T-108, T-109, T-111, TY-101, TY-104, U-110, and U-112 (8901832B). The total liquid-loss assumed for the 19 tanks was 150,000 gal, an average of approximately 8,000 gal/tank.

<sup>2</sup> Tank leak estimates were placed in one of four groups (See Section 1.2).

<sup>3</sup> Tank leak estimates for BY Tank Farm are combined in a total tank farm vadose estimate of 1,160 Ci of <sup>137</sup>Cs. The estimate is based on 1996 measurements. Volume estimates will be derived using the SIM and distributed between SSTs BY-103, BY-107, and BY-108.

<sup>4</sup> Year used in SIM to estimate tank waste composition when a leak started.

There is considerable uncertainty regarding the leak date for many of the SST leaks listed. In general, the leak dates for larger waste loss events are reasonably well known. However, for the smaller waste loss events (i.e., <3,000 gallons) many of the leak dates are highly uncertain. The leak dates for tanks SX-111, T-108 and TY-104 are leak confirmation dates identified in HNF-EP-0182 and differ from those used in SIM as of July 2005. The basis for dates used for these three tanks will be discussed in RPP-26744 (Soil Inventory Model Report [in draft]).

<sup>5</sup> Leak volumes revised per RPP-ENV-33418, revision 1. A formal tank leak status assessment for these tanks is planned in accordance with Olinger 2008.

<sup>6</sup> The estimated waste loss for tank 241-C-110 is based on waste loss through the spare inlet nozzles, as discussed in RPP-ENV-33418, rev. 1.

8901832B, 1989, "Single-Shell Tank Leak Volumes", Rev. 1, letter from R. J. Buamhardt to G. E. Gerton, U.S. Department of Energy, Richland Operations Office, dated May 17, Westinghouse Hanford Company, Richland Washington.

NA = not applicable.

SIM = Soil Inventory Model.

UPR = unplanned release.

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### 3.0 TANK-BY-TANK DISCUSSION OF LEAK VOLUME ESTIMATES

This section summarizes the technical basis for leak volume inventory estimates for 68 SSTs (see Table 2-2). These leak estimates may include losses from ancillary equipment and spills or overflows from the tank.

#### 3.1 GROUP 1 TANKS

There are 20 tanks listed in Group 1. Leak volumes and inventories are well documented and consistent with tank records, geophysical records, and other sources of information. Although these tanks are well documented and the tanks are confirmed leakers, there is still much uncertainty in the leak volume for some Group 1 tanks. Excluding SST SX-109, as a result of new information, tank leak volume estimates assigned to this group remained the same or increased compare to leak volumes presented in HNF-EP-0182. Although the leak volume estimate for SST SX-109 was changed from < 10,000 gal to 2,000 gal, the cumulative leak volume estimate for SSTs SX-107, SX-108, and SX-109 increased. The following sections provide a discussion of the basis for leak volume estimates for each of the tanks in this group.

##### 3.1.1 Single-Shell Tank 241-B-107

A leak volume of 14,000 gal was estimated for SST B-107. A leak loss of 14,000 gal was projected based on waste transfer records that show a decrease in the tank waste volume from 541,000 gal to 527,000 gal from January 1965 to June 1969 (RPP-17702, *Origin of Waste in Single-Shell Tank 241-B-107*, Appendix A; LA-UR-97-311, *Waste Status and Transaction Record Summary*). At the time the liquid-level decreases were reported, the tank contained first cycle decontamination waste/ cladding waste (1C/CW) sludge from the 221-B Bismuth Phosphate Plant and PUREX coating removal waste. Although no waste transfers were reported during this period, the waste volume measurements varied from a low value of 535,000 gal (January through June 1964) to a high value of 549,000 gal (January through June 1965). The previous leak volume estimate for this tank was 8,000 gal (HNF-EP-0182), apparently based on the lower (1964) liquid-level reading. The median value assumed for this study was based on the high electrode reading for July through December 1964 of 541,000 gal.

The spectral gamma logging data show gamma activity levels of 1,000 pCi/g of  $^{137}\text{Cs}$  at the level of the tank base in drywell 20-07-02. The activity also includes  $^{60}\text{Co}$ ,  $^{154}\text{Eu}$ , and  $^{152}\text{Eu}$ . Two drywells on the other side of the tank (20-07-08 and 20-10-02) have near-surface  $^{137}\text{Cs}$  contamination (< 10 pCi/g) and apparent deep (70 to 85 ft below ground surface [bgs])  $^{90}\text{Sr}$  contamination (GJ-HAN-128, *Tank Summary Data Report for Tank B-107*).

##### 3.1.2 Single-Shell Tank 241-BX-101

The leak volume estimate for SST BX-101 was changed to 4,000 gal. Although no previous leak volume was reported for this tank, the spectral gamma logging data clearly indicate a plume emanating from the tank dome. Although the presence of a leak is well documented, the quantity

of waste lost to the soil column is highly uncertain. SST BX-101 was classified as an assumed leaker in 1972 based on unexplained drywell activity observed near the tank (HNF-4872, *Single-Shell Tank Leak History Compilation*). The leak history for SST BX-101 indicates that a leak originated from a pump pit on the dome of the tank (RPP-10098). However, approximately 25 Mgal of high-activity waste moved through this tank from 1968 until the end of 1972, and there may have been an active leak from the SST BX-101 pump pit over this four-year period (GJ-HAN-95, *Tank Summary Report for Tank BX-101*). Two drywells (21-01-01 and 21-01-02) near SST BX-101 exhibit significant contamination (GJO-HAN-19). The leak volume estimate for SST BX-101 of 4,000 gal is highly speculative and based on apparent unexplained liquid level decrease in the waste transfer records over this time period (RPP-7389).

Additional vadose zone characterization activities are scheduled in the region around tank BX-101 to help resolve the uncertainties about the volume of waste associated with this leak.

### 3.1.3 Single-Shell Tank 241-BX-102

The leak volume estimate for SST BX-102 was increased from 70,000 to 91,600 gal. The previous estimate of 70,000 gal was based on a 1972 analysis of neutron logging data and gamma activity and assumed that high gamma activity was primarily from  $^{137}\text{Cs}$  (ARH-2035, *Investigation and Evaluation of 102-BX Tank Leak*). The increased volume estimate is a result of evidence that became publicly available in the mid-1990s showing that SST BX-102 was overfilled in 1951, and this overflow event resulted in the loss of an estimated 91,600 gal of metal waste to the soil (HW-20438, pg 51, *Hanford Works Monthly Report for February 1951* and HW-20742, *Loss of Depleted Metal Waste Supernatant to Soil*). Spectral gamma logging data obtained since the 1972 analysis show a  $^{238}\text{U}$  plume from the tank overflow event and a complex array of gamma emitting radionuclides (RPP-10098). Gamma analyses show that little  $^{137}\text{Cs}$  was in the high gamma activity region reported in ARH-2035; rather the contamination is a combination of  $^{106}\text{Ru}$ ,  $^{60}\text{Co}$ , and  $^{125}\text{Sb}$ .

### 3.1.4 Single-Shell Tank 241-C-105

A 40 to 2,000 gal leak is estimated for SST C-105 ancillary equipment (RPP-ENV-33418). No previous leak volume is identified in HNF-EP-0182 for this tank. SST C-105 is not classified as an assumed leaker (HNF-EP-0182) because documentation on SSTs C-104 and C-105 refer to a tank leak in the cascade line between the two tanks. Gamma-ray log data from boreholes in the region between these two tanks also suggest a cascade line leak (RPP-20820, *Waste Retrieval Leak Evaluation Report: Single-Shell Tanks*). The leak was first found in October 1967 (RPP-RPT-29191). However, no documentation was found showing when the leak actually occurred or verifying that it was a cascade line leak (WHC-SD-EN-TI-185, *Assessment of Unsaturated Zone Radionuclide Contamination Around Single-Shell Tanks 241-C-105 and 241-C-106*, p.16).

The data are inconclusive as to the source of the cesium plume observed in drywells nearby this tank. Regardless of the source of the contamination, a contaminant plume clearly exists. Based on the plume size estimated from  $^{137}\text{Cs}$  distribution and concentration measurements in drywells, the leak volume was estimated to be 40 to 2,000 gal (RPP-ENV-33418 section 4.4.5). A larger

plume would be expected to show substantially higher activity levels in one or more of the surrounding drywells.

### 3.1.5 Single-Shell Tank 241-S-104

The leak volume for SST S-104 was unchanged at 24,000 gal. SST S-104 is estimated to have lost 24,000 gal, probably through a spare inlet port, based on unexplained liquid-level decreases from 1966 through 1970 (RPP-6285, HNF-EP-0182). SST S-104 was declared a confirmed leaker in 1968. Based on soil contamination levels and waste transfer records, the fluids lost were likely aluminum cladding waste. A 24,000 gal loss of reduction and oxidation (REDOX) cladding waste would involve the loss of approximately 550 Ci of  $^{137}\text{Cs}$ . This level of  $^{137}\text{Cs}$  contamination is consistent with the  $^{137}\text{Cs}$  activity found in one nearby drywell, near the spare inlet ports, and found in cone penetrometer pushes around this drywell (GJ-HAN-73, *Tank Summary Data Report for Tank S-104*; RPP-7884).

### 3.1.6 Single-Shell Tank 241-SX-107

The estimated leak volume for SST SX-107 was increased from < 5,000 to 15,000 gal. This tank was classified as a confirmed leaker in 1964 based on drywell activity. The revised leak volume was scaled to a 35,000 gal leak from SST SX-108 based on  $^{137}\text{Cs}$  kriging analysis (RPP-20420, *241-S-SX Waste Management Area Inventory Data Package*). The kriging analysis is essentially a means of ratioing cesium distribution between the tanks. The original kriging analysis (HNF-5782, *Estimation of SX-Farm Vadose Zone Cs-137 Inventories from Geostatistical Analysis of Drywell and Soil Core Data*) estimated a 6,350 gal leak volume for SX-107 based on a 15,200 gal leak for SST SX-108. This is close to the previous leak volume estimate of < 5,000 gal (HNF-EP-0182). However, given the poorly defined uncertainty for the kriging analysis, the ratio of the leak volumes derived from the kriging analysis for SSTs SX-107, SX-108, and SX-109 (6,350 gal, 15,200 gal, and 989 gal, respectively) was applied to an upper 35,000 gal leak estimate for SST SX-108 resulting in a 15,000 gal estimate for SST SX-107.

### 3.1.7 Single-Shell Tank 241-SX-108

The best leak volume estimate for SST SX-108 was determined to be the maximum value presented in HNF-EP-0182 of 35,000 gal. SST SX-108 is a confirmed leaker based on drywell activity. Previous leak estimates range from 2,400 to 35,000 gal (HNF-EP-0182) based on a 1992 leak assessment (WHC-MR-0300, *Tank 241-SX-108 Leak Assessment*). The first leak was noted in 1964 during sodium-nitrate recovery operation (BNWL-CC-701, *Characterization of Subsurface Contamination in the SX Tank Farm*; WHC-MR-0300) and quantified as a 24,000 gal leak based on soil sample analyses (WHC-MR-0300). A second major leak from this tank was believed to have begun in 1966 when the tank was filled with REDOX HLW. Extensive historical documentation is available for the tank leak, and extensive field investigations were performed assessing this leak including lateral, drywell, and in-tank investigations. As part of the WMA S-SX field investigation report (RPP-7884), a leak volume of 15,200 gal was developed for SST SX-108 based on geo-statistical (kriging) analysis of spectral gamma logging and soil analysis data (HNF-5782). Given poorly defined uncertainty for the kriging analysis results and a possibility that results may be low by as much as a factor of two, the upper

35,000 gal leak volume was assumed for S-SX risk assessments (RPP-20420). Kriging analyses for SSTs SX-109 and SX-107 were increased proportionally.

### 3.1.8 Single-Shell Tank 241-SX-109

The estimated leak volume for SST SX-109 was changed from < 10,000 gal to 2,000 gal. SST SX-109 was classified as a confirmed leaker based on drywell activity (HNF-EP-0182). As noted in Section 3.1.7, leak volumes for SST SX-109 were scaled to the leak from SST SX-108 based on  $^{137}\text{Cs}$  kriging analysis (HNF-5782). Originally, the leak volume estimate for SST SX-109 was determined to be "small" (ARH-R-43, *Management of Radioactive Waste Stored in Underground Tanks at Hanford*; BNWL-CC-701). An estimate of < 5,000 gal was given in 1983 (PNL-4688 UC-70, *Assessment of Single-Shell Tank Liquid Residual Issues at Hanford Site, Washington*), but this estimate was never substantiated. In 1992, the leak volume was estimated as < 10,000 gal (WHC-MR-0301, *Tank 241-SX-109 Leak Assessment*) based on lateral activity measurements and engineering judgment. Subsequent, kriging analysis indicated that more of the waste was derived from SST SX-107 and less from SST SX-109 as originally suspected (ARH-R-43). The SST SX-109 contained REDOX sludge and supernatant boiling waste at the time of the suspected tank leak.

### 3.1.9 Single-Shell Tank 241-SX-113

The estimated leak volume for SST SX-113 remains unchanged at 15,000 gal. The tank is classified as a confirmed leaker based on a liquid-level decrease during a tank leak test (HW-75714, *Leak Testing of the 113-SX Tank*). The base of SST SX-113 bulged during the initial filling with REDOX HLW. The tank was pumped to a minimum heel, drywells were installed, and five laterals were placed under the tank for gross gamma logging (RPP-20420). Over a two-year period, no activity was detected in the laterals or drywells. In 1962, 208,000 gal of dissolved sludge waste was transferred from SST SX-114 to SST SX-113 as a tank-leak test. A leak volume of 15,000 gal was measured during the leak test (HW-75714). The tank was pumped to a minimum heel and taken out of service.

### 3.1.10 Single-Shell Tank 241-SX-115

The estimated leak volume for SST SX-115 remains unchanged at 50,000 gal. The 50,000 gal loss from SST SX-115 is well documented (BNWL-CC-701). Extensive historical documentation is available for the tank leak (WHC-MR-0302, *Tank 241-SX-115 Leak Assessment*). Waste transfer records and waste types also indicate a 50,000 gal loss for the SST SX-115 leak event (RPP-6285).

### 3.1.11 Single-Shell Tank 241-T-101

The estimated leak volume for SST T-101 was increased from 7,500 gal to 10,000 gal based on tank transfer and surveillance records. SST T-101 was classified as an assumed leaker in 1992 with a leak volume of 7,500 gal based on a liquid-level decrease (HNF-EP-0182). This tank was overfilled in the 1960s and is reported to have lost an unknown quantity of REDOX cladding waste through a defective spare inlet port in 1969 (GJ-HAN-115, *Tank Summary Data Report for*

*Tank T-101*). The location (drywell 50-01-04) and the  $^{137}\text{Cs}$  profile found during spectral gamma logging are consistent with waste loss through a spare inlet port. Contamination profiles in drywells 50-01-06 and 50-01-09 suggest near-surface leaks of REDOX ion-exchange waste stored in this tank in the early 1970s. Based on analysis of waste transfer records, the leak volume associated with the tank overflow event was increased to 10,000 gal and the waste composition is based on a leak in that time frame (RPP-7218). Additional field characterization is planned near this tank.

### 3.1.12 Single-Shell Tank 241-T-103

The estimated leak volume for SST T-103 was increased from < 1,000 gal to 3,000 gal based on tank transfer and surveillance records. A leak volume of < 1,000 gal is listed for this tank with a declared leak date of 1974 (HNF-EP-0182). The contamination around SST T-103 has been suggested to have originated from a waste loss through a spare inlet port when the tank was overfilled in 1972 and 1973 (GJ-HAN-117, *Tank Summary Data Report for Tank T-103*). The radionuclide profiles suggest a B Plant origin for the lost tank waste. Analysis of tank transfer records suggests a 3,000 gal leak volume, which will be used for risk assessments. A detailed description and leak evaluation of SST T-103 is contained in RPP-20820 and RPP-7123.

### 3.1.13 Single-Shell Tank 241-T-106

The estimated leak volume for SST T-106 remains the same at 115,000 gal. The 115,000 gal leak from SST T-106 in 1973 was the largest waste-loss event recorded at the Hanford Site. It is well documented in RHO-ST-14, *High-Level Waste Leakage from the 241-T-106 Tank at Hanford*. Data are available from analyses of waste performed at the time of the leak. Additional field characterizations are planned near this tank. Additional information about the tank and leak is presented in RPP-7123 and GJO-HAN-27.

### 3.1.14 Single-Shell Tank 241-TX-107

The leak volume estimate for SST TX-107 was increased from 2,500 gal to 8,000 gal. A leak volume of 2,500 gal for this tank and a declared leak date of 1984 (HNF-EP-0182) was based on increasing activity in nearby drywells (Occurrence Reports 77-103 and 83-22). The zones at 50 to 70 ft bgs in drywells 51-07-18 and 51-07-07 are contaminated with  $^{60}\text{Co}$  and  $^{154}\text{Eu}$ , as are other drywells between SSTs TX-103 and TX-107. SST TX-107 was used as the 242-T Evaporator feed/bottoms recycle tank in 1975, apparently handling B Plant  $^{90}\text{Sr}$  recovery waste. The gamma plumes (i.e.,  $^{60}\text{Co}$  and  $^{54}\text{Eu}$ ) around this tank indicate a substantial leak volume. The leak volume was increased to 8,000 gal based on plume size estimates. The actual value is uncertain (RPP-7218). Additional description of the tank and leak information is presented in RPP-7123 and GJO-HAN-11. Results from a field characterization program are presented in WHC-MR-0132, *A History of the 200 Area Tank Farms*.

### 3.1.15 Single-Shell Tank 241-TY-103

The previous leak estimate for SST TY-103 of 3,000 gal is not changed. A leak volume of 3,000 gal and a declared leak date of 1973 were assigned based on an unexplained liquid-level

decrease (HNF-EP-0182). Spectral gamma logging data from drywell 53-03-03 indicates  $^{137}\text{Cs}$  contamination near the base of this tank that could have originated from a tank leak or from waste transfer lines. Drywells 53-03-06 and 53-03-12 have deep  $^{60}\text{Co}$  contamination (GJO-HAN-16). The combination of  $^{137}\text{Cs}$  and  $^{60}\text{Co}$  suggests tributyl phosphate (TBP) or B Plant waste source (RPP-7218). This tank stored TBP waste from 1957 through early 1968. From 1968 through 1973, SST TY-103 contained PUREX and B Plant waste. Additional information about the tank and leak is presented in RPP-7123 and GJO-HAN-16.

### 3.1.16 Single-Shell Tank 241-TY-105

The previous leak estimate for SST TY-103 of 35,000 gal is not changed. A leak volume of 35,000 gal and a leak date of 1960 were assigned based on drywell activity and waste transfer records which show an unaccounted-for 35,000-gal liquid-level decrease of TBP waste in 1959. The limited number of drywells around this tank indicates gamma contamination that is consistent with loss of TBP waste (GJO-HAN-16). Both  $^{137}\text{Cs}$  and  $^{60}\text{Co}$  were found in drywells 52-03-06, 52-05-07, and 52-06-05. TBP waste was the only waste type added to this tank (RPP-7218). Additional information about the tank and leak is presented in RPP-7123.

### 3.1.17 Single-Shell Tank 241-TY-106

The previous leak estimate for SST TY-106 of 20,000 gal is not changed. A leak volume of 20,000 gal and a leak date of 1959 were assigned based on increased drywell activity in four of five nearby wells (HNF-EP-0182). In February 1972, diatomaceous earth was added to the tank in an attempt to stabilize it. SST TY-106 received waste from SST TY-105 through the cascade line. Thus, both tanks contained TBP waste. Although the waste transfer records indicate an apparent waste loss in 1959, the data are ambiguous (RPP-7218). Additional information about the tank and leak is presented in RPP-7123 and GJO-HAN-16.

### 3.1.18 Single-Shell Tank 241-U-104

The previous leak estimate for SST U-104 of 55,000 gal (HNF-EP-0182) is not changed. A 55,000 gal leak from SST U-104 occurred in the early 1950s when physical inspection of the tank interior (GJ-HAN-33, *Tank Summary Data Report for Tank U-104*) revealed a tank bottom bulge in the northeast quadrant of the tank. Spectral gamma-uranium activity data in ten drywells around SST U-104 and to the southwest indicate the occurrence of a high-uranium waste leak with SST U-104 being the source. Maximum uranium concentrations over the largest depth intervals occur in drywells 60-07-11, 60-07-10, and 60-04-08 on the south and southwest side of SST U-104. In these drywells, contamination occurs just below the tank bottom about 52 ft (16 m) bgs and extends to as much as 92 ft (28 m) bgs. Uranium-235 concentrations up to 100 pCi/g and  $^{238}\text{U}$  concentrations approaching 1,000 pCi/g near tank bottom depth have been measured. These drywells were located closest to the leak location. Given the extent of the uranium contamination footprint in the vadose zone, the leak volume estimate may be larger than 55,000 gal. However, pending additional characterization/analysis, the leak estimate was not changed. Additional information about the tank and leak is presented in RPP-15808.

### 3.1.19 Single-Shell Tank 241-U-110

The previous leak estimate for SST U-110 of 5,000 gal to 8,100 gal (HNF-EP-0182) was not changed. However, a single value of 6,500 gal was selected. An SST U-110 leak was reported in 1975 based on increased gamma activity in drywell 60-10-07 and a liquid-level decrease inside the tank (SD-WM-TI-356, *Waste Storage Tank Status and Leak Detection Criteria*). The tank leak volume is estimated to range between 5,000 and 8,100 gal (HNF-EP-0182; SD-WM-SAR-006, *Single-Shell Tank Isolation Safety Analysis Report*). Both spectral gamma data and the historical gross gamma record are consistent with a tank leak. An average leak volume of 6,500 gal was assumed (RPP-16608, *Site-Specific Single-Shell Tank Phase 1 RCRA Facility Investigation/Corrective Measures Study Work Plan Addendum for Waste Management Areas C, A-AX, and U*). Additional information about the tank and leak is presented in RPP-15808 and GJO-HAN-8.

### 3.1.20 Single-Shell Tank 241-U-112

The previous leak estimate for SST U-112 of 8,500 gal (HNF-EP-0182) was not changed. SST U-112 was classified as a confirmed leaker in 1970 with leak volume of 8,500 gal based on a liquid-level decrease (HNF-EP-0182). A review of historical leak information provided in RPP-20820, Section 4.9, indicates the leak volume may have been larger. SST U-112 appears to have leaked in a similar fashion to SST U-110. One drywell, 60-02-01, shows two distinct high  $^{137}\text{Cs}$  concentration zones near the tank bottom between 50 and 68 ft (15 and 21 m) bgs. Concentrations exceeding 107 pCi/g are common and a maximum value near 109 pCi/g occurs near 60 ft (18 m) bgs. A second less concentrated zone occurs between 83 and 97 ft (25 and 30 m) bgs where  $^{137}\text{Cs}$  concentrations largely fall between 104 and 105 pCi/g. The bifurcated zones could indicate more than one leak (RPP-15808). However, pending additional characterization/analysis, the previous leak estimate was not changed.

## 3.2 GROUP 2 TANKS

There are 22 tanks listed in Group 2. The leak volumes shown in HNF-EP-0182 for these tanks were not changed. In some cases, the "leak" appears to have originated near surface. For example, review of available information for SST C-110 indicates waste loss was due to overflow through the spare inlet pipes (RPP-ENV-33418 section 4.2.5). The logic leading to the leak volume estimates for these tanks vary in both level of sophistication and reproducibility. Leak volume estimates in this category generally are too small to be supported by vadose estimates or technical arguments and appear to be conservative. However, information available at the time but not recorded in a retrievable archive; loss of key personnel over the years; and the small size of many of the leaks make any current formal reevaluation likely to yield questionable results. Because new field data does not add new information to validate or change these estimates, the leak volume estimates shown in HNF-EP-0182 for these 22 tanks were not changed. Inventory estimates in SIM will be developed based on the concentration of liquid waste types in a tank at the time the liquid-level decrease occurred.

The 22 tanks in Group 2 are SSTs A-103, A-104, AX-102, B-110, B-112, B-201, B-202, B-204, BX-108, C-101, C-110, C-201, C-202, C-203, C-204, SX-104, SX-111, T-108, T-109, T-111, TY-101, and TY-104.

No further description or discussion of these tank/ancillary equipment leak volume estimates is included in this document. Leak volume estimates for these tanks are shown in Table 2-2.

### 3.3 GROUP 3 TANKS

Group 3 includes eight SSTs on the "confirmed or suspected" leaker list for which current vadose zone drywell and/or lateral measurements and investigations indicate that previous leak volume estimates were high. The leak volume estimates for four tanks in this group were reduced. These tanks include SSTs A-105, SX-110, SX-112, and U-101. Previous leak volume estimates for these tanks were 10 kgal, 5.5 kgal, 30 kgal, and 30 kgal, respectively (HNF-EP-0182), and involve REDOX or PUREX HLW. Given the high-heat load of these waste types and understanding of fluid-flow in the Hanford Site's unsaturated soils, it is highly unlikely that a leak volume of these magnitudes would not have been detected by the secondary leak monitoring (i.e., the drywell gross gamma logging) system.

The leak volumes for SSTs BY-103, BY-107, and BY-108 will also be reduced. Vadose zone drywell logging shows extensive surface contamination near these tanks. Much of the liquid-level decreases may be accounted for by evaporation, and intermixing makes it difficult to determine the contamination source. A cumulative estimate of contamination observed in drywells near these three tanks and the size of contamination plumes was performed and is described in Section 3.3.2. An estimate of approximately 1,160 Ci of  $^{137}\text{Cs}$  in the BY Tank Farm vadose zone was developed for these tanks. The  $^{137}\text{Cs}$  inventory assigned to each of the BY Tank Farm tanks/ancillary equipment was proportional to the leak volumes presented in HNF-EP-0182, (5,000 gal for BY-103, 15,100 gal for BY-107 and 5,000 gal for BY-108) resulting in  $0.2 \times 1,160$  or 232 Ci for SSTs BY-103 and BY-108 and 928 Ci for SST BY-107. Total inventories and leak volume estimates will be developed in the SIM based on knowledge of waste types in these tanks at the times of waste-loss events.

A review of waste transfer records and process information had led to the conclusion that SST C-111 has been erroneously characterized as an assumed leaker. Process information indicates the observed waste level decline in SST C-111 that occurred from 1965-1969 is attributed to evaporation as a result of radiolytic decay heat from  $^{144}\text{Ce}$ . Therefore, the estimated waste loss from SST C-111 has been revised from 5,500 gal to zero.

A more detailed discussion of each of the tanks in this group, the basis for reducing leak volume estimates, and calculations and assumptions for BY-tank Ci estimates follows.



### 3.3.1 Single-Shell Tank 241-A-105

The estimated leak volume for SST A-105 was decreased from a range of 10,000 to 277,000 gal to a nominal 1,000 gal. This is by far the biggest change presented in this report and one of the most controversial.

The previous leak volume estimate for this event is 10,000 to 277,000 gal, including 10,000 to 45,000 gal of waste prior to November 1970 and 0 to 232,000 gal of cooling water (HNF-EP-0182). An estimated 610,000 gal of cooling water was added to the tank between November 1970 and 1978 with a minimum evaporation estimate of 378,000 gal (WHC-MR-0264, *Tank 241-A-105 Leak Assessment*). A net maximum volume of 232,000 gal of cooling water assumed to have leaked to the vadose zone; however, "sufficient heat was generated in the tank to evaporate most, and perhaps nearly all, of the water" (WHC-MR-0264) to provide a minimum value of 0. Cooling water additions were not included in the nominal 1,000 gal estimate because the water does not contribute to the volume or inventory of waste leaked to the vadose zone. The quantity of cooling water leaked to the vadose zone is assumed to range between 0 and 232,000 gal (WHC-MR-0264).

Subtracting cooling water additions leaves 10,000 to 45,000 gal of liquid waste to account for. The spectral gamma logging data are inconsistent with a 10,000 gal loss of PUREX HLW from SST A-105 to the soil. Analytical data show that the  $^{137}\text{Cs}$  concentration in SST A-105 supernatant at the time of the steam release event was 8.1 Ci/L (31 Ci/gal) (ARH-78, *PUREX TK-105-A Waste Storage Tank Liner Instability and its Implications on Waste Containment and Control*). Thus, a 10,000-gal leak volume would require that 310,000 Ci of  $^{137}\text{Cs}$  were lost to the soil column. However, the drywells around SST A-105 have very low levels of  $^{137}\text{Cs}$  contamination ( $< 100$  pCi/g).

In 1963, the first recorded leak from SST A-105 was reported (ARH-78). The estimate for this leak was 5,000 to 15,000 gal based on drywell measurements available at the time (WHC-MR-0264). The dry lateral [10-05-Lateral 3] posted a radiation contamination level of 17,000 cpm gamma. Seven days later that measurement jumped to 150,000 cpm gamma and 0.75 R/h. Over a three-month period, the contamination decreased to 50,000 cpm. A leak was the assumed cause for the sudden increase and eventual decrease in radioactive contamination. In comparison, inside the waste tank, a radioactive contamination measurement was taken at 40,000 R/h (millions of cpm). Tank Farm condensate was added just before the assumed leak occurred. The radioactivity of the condensate added to the tank was measured at 200 cpm. After the condensate was added, the in-tank condensate was measured at 8,000 cpm. The leak was assumed to be small due to the minimal amount of radiation present in the lateral compared to the expected radioactivity for a larger leak from the tank (ARH-78). The tank was again filled to capacity by December 1964 with no indications of a leak.

The most serious waste-loss event from WMA A-AX occurred in SST A-105 in January 1965 (ARH-78). The tank was filled to capacity with PUREX HLW in a boiling state. The extreme high-heat load led to an intense steam release event that lasted for 30 minutes. This event also caused a bulge in the bottom inner liner upward to an estimated 8.5 ft at one point, ripped the liner away from the sidewall, and displaced approximately 80,000 gal of liquid (void volume estimate) within the tank. The tank was closely monitored for several years with no evidence of

additional leakage. However, some liquid-level losses were noted during the final attempt to sluice the hard heel from the tank. Following the unsuccessful attempt to remove the hard heel, water was added to the tank for evaporative cooling for almost a decade.

Thirty-nine days after the “steam event,” 10-05-Lateral 3 posted a radioactive contamination measurement of 3,000,000 cpm; it also read 50,000 cpm from the leak detected two years earlier. The thermal temperature measured in a second set of laterals installed just below the base of the tank was 310 °F (90 ft horizontal from the caisson). Tank Farm officials, fearing a leak from SST A-105, had three test wells drilled in the general area of 10-05-Lateral 3 to intercept and analyze the leaked substance. All three test wells were drilled and sampled to approximately 65 ft bgs. Analysis showed no signs of radioactive materials, and maximum soil temperature for all three wells at 206 °F (ARH-78). In 1998, the 10-05-Lateral 3 temperature was measured at 233 °F. Although the lateral readings and temperature were high, they were still very low compared to in-tank measurements and activity levels expected for a PUREX HLW leak.

Information provided by Pacific Northwest National Laboratory (PNNL) in past reports (ARH-78; BNWL-CC-376, *Techniques for Calculating Tank Temperatures and Soil Temperatures Near Leaks – Application to PUREX Waste Tank 105A*) indicate if a minimal amount [~ 175 gal] of solution or supernatant liquid was transferred from SST A-105 to the soil, the resultant temperature could be in excess of +1,500 °F. A 1970 report (ARH-R-43) does not estimate a leak volume, but indicates the volume was “small” and assumes that the leak had self sealed and that periodic liquid fluctuations and a bulge under the liner were attributed to movement of solution in and out of the space between the bulged liner and the concrete bottom through a break in the liner. The liquid was removed during the June 1968 period.”

A 1977 study (Woodward-Clyde 1978, *An Estimate of Bottom Topography, Volume and other Conditions in Tank 105A, Hanford, Washington*) estimated that 21,000 gal of sludge was trapped between the bulged liner and the tank wall. This sludge waste is part of the in-tank best-basis inventory (BBI) estimate (Tank Waste Information Network System [TWINS] 2004) for tank residuals and is in addition to an estimated 16,000 gal of sludge “in the tank.” The 21,000 gal is well above a 10,000-gal leak estimate.

This drywell and lateral data do not support a 10,000-gal leak estimate. A previous assessment (WHC-MR-0264) concluded that based on the PNNL study (ARH-78) and the fact that the temperature in the laterals never exceeded 350 °F, it appears likely that very little if any of the solid sludge materials escaped from the tank. The PNNL study provides the only available quantification for how much waste might have reached the soil as “less than 175 gal.” This is not to say that the tank leak volume was not higher than 175 gal, but suggests that waste that leaked from the tank was likely diluted, and the inventory of PUREX HLW that leaked from the tank appears to be lower than previously predicted. WHC-MR-0264 also concludes that the leaks were “small” because horizontal spreading was not observed and radiation readings detected are a small fraction of the radiation reading in the tank. In addition, the activity level and temperatures were significantly lower than expected in laterals only 10 ft below the tank. Not only was there no evidence of activity in drywells in place at the time, but no activity was found in three new drywells that were drilled after the leak events occurred. These drywells

were located near high-activity measurements in the laterals in an effort to further characterize SST A-105 contamination and the plume size.

In light of the available information, a nominal volume of 1,000 gal of PUREX high-level supernatant in the vadose zone was assumed. Attempts to re-log the laterals under SST A-105 using a spectral gamma logging tool are part of the A Tank Farm vadose zone investigations. Such data will further quantify the  $^{137}\text{Cs}$  plume in the soil directly below the tank. The results for SST A-105 will be revised after the new spectral gamma lateral data are obtained.

### 3.3.2 Single-Shell Tanks 241-BY-103, BY-107, and BY-108

An estimate of approximately 1,160 Ci of  $^{137}\text{Cs}$  in the BY Tank Farm vadose zone was developed for SSTs BY-103, BY-107, and BY-108. Volumes and inventories for  $^{137}\text{Cs}$  and other waste constituents will be developed in the SIM based on knowledge of waste types in these tanks at the times of waste-loss events.

Tanks and surface-level contamination in BY Tank Farm are intermixed and make it difficult to distinguish which tanks leaked and how much. However, vadose data shows extensive  $^{137}\text{Cs}$  surface (top 0 to 40 ft) contamination in BY Tank Farm attributed to tank leaks, pipeline losses, and spills. These pipeline leaks and spills are not accounted for in the UPRs shown in Section 4.0. Therefore, in place of questionable and highly uncertain individual tank leak estimates and possible overlap or duplication, a single BY Tank Farm vadose zone inventory attributing to tanks and ancillary equipment for SSTs BY-103, BY-107, and BY-108 was developed from spectral gamma logging data.

SSTs BY-103, BY-107, and BY-108 are classified as assumed leakers based on low levels of unexplained activity in nearby drywells (HNF-EP-0182).

SST BY-103 was declared a leaker based on drywell activity with a leak volume of < 5,500 gal (HNF-EP-0182). Drywell monitoring data (drywell 22-03-09) shows  $^{137}\text{Cs}$  activity near the surface indicating that the contamination may have come from a near-surface leak associated with a leak detected in early 1973 when the tank contained about 14 ft of wet salt. After removing approximately 44,000 gal of saltwell liquor, future  $^{60}\text{Co}$  activity increases found near the tank base may be attributed to migration from the cesium activity source (OR-74-106, *Increasing Radioactivity in Dry Well 22-03-09 at Tank 103-BY*).

SST BY-107 is classified as a confirmed leaker based on an unexplained liquid-level decrease with a leak volume of 15,100 gal (HNF-EP-0182). A 1974 occurrence report (OR-74-27, *Significant Liquid Level Decrease – Tank 241-107-BY*) notes that the liquid level decreased beyond that expected due to surface crusting and exhauster operation. Radiation peak readings were observed in a drywell near the northeast quadrant of the tank. The tank was shut down in June 1973, and approximately 167,000 gal of liquid were removed from the tank during April 1974. The surface level appeared to stabilize after pumping; however, accelerated removal of liquids continued as a precaution. The 1975 increases in drywell activity were probably caused by redistribution of contamination in the soil. Drywells on the east side of SST BY-107 show a high amount of moisture in the soil attributed to moisture intrusion from a nearby french

drain and a raw water outlet between SSTs BY-104, BY-105, BY-107, and BY-108 (OR-75-56, *Increasing Dry Well Radiation Adjacent to Tank 107-BY*).

SST BY-108 is classified as a confirmed leaker with a leak volume of  $< 5,500$  gal based on high radiation readings, frequent scintillation-probe checks, coupled with neutron-probe readings revealed an active leak near the bottom and northerly quadrant of the tank in June 1971 (PPD-453, *Monthly Status and Progress Report*, June 1971 P. AIV-18). Pumping started January 1972.

The spectral gamma logging data provide evidence that waste-loss events in the BY Tank Farm originated from within 25 ft of the ground surface. The vadose zone of this tank farm is highly contaminated with  $^{137}\text{Cs}$  near surface while deeper gamma activity comes from  $^{60}\text{Co}$ .

Most BY Tank Farm drywells were installed in the early to mid-1970s. In the 1970s, high levels of gross gamma activity were observed near or below the base of a number of BY Tank Farm tanks. The high levels of gross gamma activity near or below the base of these tanks were interpreted as strong evidence for leaks from any nearby tank. However, the spectral gamma logging data (GJO-HAN-6) provides a significantly different interpretation. In the year 2000, the activity near and below the base of the tanks in the BY Tank Farm was  $^{60}\text{Co}$ . The historical gross gamma logging data were evaluated in HNF-3532 in 1999. Their analysis showed that many of the drywells had high levels of  $^{60}\text{Co}$ ,  $^{106}\text{Ru}$ , and  $^{125}\text{Sb}$  activity near and below the base of a number of tanks in the mid- and late-1970s. Almost all of the high  $^{137}\text{Cs}$  activity was between 0 and 20 ft bgs. Based on our current understanding of  $^{137}\text{Cs}$  migration in the Hanford Site subsurface, these data demonstrated that the waste-loss events in the BY Tank Farm originated in this region between 0 and 20 ft bgs.

Leak volumes that are reported for BY Tank Farm are questionable. The leak volumes were reported more than ten years ago after an initial concern about high gamma activity observed in drywells. These tanks were flagged as potential leakers. As a result, a total BY Tank Farm vadose zone  $^{137}\text{Cs}$  inventory estimate was developed from spectral gamma logging data. Results from this approach are reported below. The total  $^{137}\text{Cs}$  activity can be used to develop inventories for other chemicals and radionuclides.

The BY Tank Farm spectral gamma logging data (GJO-HAN-6) identify five regions of high  $^{137}\text{Cs}$  gamma activity (i.e., at  $> 1\text{E} + 04$  pCi/g). The decay date for these  $^{137}\text{Cs}$  estimates is 1996 (the date data was collected). The regions are as follows:

1. Drywells 22-08-01 and 22-08-02 from 2 to 7 ft bgs at  $1\text{E} + 05$  pCi/g (assume a 50-ft diameter circular plume).
2. Drywell 22-05-01 from 0 to 3 ft bgs at  $1\text{E} + 04$  pCi/g (assume a 25 ft circle).
3. Drywell 22-12-03 from 5 to 7 ft bgs at  $1\text{E} + 04$  pCi/g (assume a 25 ft circle).
4. Drywell 22-03-05 from 27 to 45 ft bgs at  $3\text{E} + 03$  to  $4\text{E} + 07$  pCi/g (assume a 25 ft circle).

5. Finally, there is the generally contaminated region from 0 to 10 ft bgs all across the BY Tank Farm at  $< 1\text{E} + 02$  pCi/g.

Assuming an average soil density of  $1.8 \text{ g/cc}$ ,  $1 \text{ ft}^3$  equals  $2.832\text{E} + 04 \text{ cm}^3$ , thus,  $1 \text{ ft}^3$  would contain  $5.1\text{E} + 04 \text{ g}$  of soil. A 25-ft circle of cesium contamination with a 1 ft depth would contain  $491 \text{ ft}^3$  or  $2.5\text{E} + 07 \text{ g}$  of soil. A 50-ft circle 1 ft thick would include  $1,964 \text{ ft}^3$  or  $5.561\text{E} + 07 \text{ cm}^3$  or  $1.0\text{E} + 08 \text{ g}$  of soil. A 5-ft thick plume would include  $5.0\text{E} + 8 \text{ g}$  of soil.

1. Drywells 22-08-01 and 22-08-02 from 2 to 7 ft bgs at  $1\text{E} + 05$  pCi/g (assume a 50-ft diameter circular plume). A  $^{137}\text{Cs}$  activity of  $1\text{E} + 05$  pCi/g would lead to an estimate of 50 Ci of  $^{137}\text{Cs}$  in this plume.
2. Drywell 22-05-01 from 0 to 3 ft bgs at  $1\text{E} + 04$  pCi/g (assume a 75-ft circle). This leads to an estimate of 0.25 Ci of  $^{137}\text{Cs}$  in this plume.
3. Drywell 22-12-03 from 5 to 7 ft bgs at  $1\text{E} + 04$  pCi/g (assume a 25-ft circle). This leads to an estimate of 0.5 Ci of  $^{137}\text{Cs}$  in this plume.
4. Because of the depth and activity variations in the plume associated with drywell 22-03-05, a "layer cake" model was used to develop the inventory estimate. The "layer cake" model for drywell 22-03-05 assumes a 25-ft diameter circle. According to the layer cake model:
  - From 27 to 32 ft bgs,  $^{137}\text{Cs}$  activity =  $2\text{E} + 04$  pCi/g. This leads to an estimate of 2.5 Ci of  $^{137}\text{Cs}$ .
  - From 32 to 34 ft bgs,  $^{137}\text{Cs}$  activity =  $1\text{E} + 06$  pCi/g. This leads to an estimate of 50 Ci of  $^{137}\text{Cs}$ .
  - From 34 to 35 ft bgs,  $^{137}\text{Cs}$  activity =  $4\text{E} + 07$  pCi/g. This leads to an estimate of 1,000 Ci of  $^{137}\text{Cs}$ .
  - From 35 to 37 ft bgs,  $^{137}\text{Cs}$  activity =  $1\text{E} + 06$  pCi/g. This leads to an estimate of 50 Ci of  $^{137}\text{Cs}$ .
  - From 37 to 45 ft bgs,  $^{137}\text{Cs}$  activity =  $1\text{E} + 04$  pCi/g. This leads to an estimate of 2 Ci of  $^{137}\text{Cs}$ .
  - The "layer cake" model estimate for the plume around drywell 22-03-05 leads to an estimate of approximately 1,100 Ci of  $^{137}\text{Cs}$ .
5. Finally, there is the generally contaminated region from 0 to 10 ft bgs all across the BY Tank Farm at  $< 1\text{E} + 02$  pCi/g. Assume the tank farm is 300 by 400 ft. The total volume is  $1.2\text{E} + 06 \text{ ft}^3$ . This leads to  $6.12\text{E} + 10 \text{ g}$  of soil. At a uniform activity of 100 pCi/g leads to an estimate of 6.1 Ci of  $^{137}\text{Cs}$ .

This analysis leads to an estimate of approximately 1,160 Ci of  $^{137}\text{Cs}$  in the BY Tank Farm vadose zone. Volumes and inventories for other waste constituents will be developed from knowledge of waste types in these tanks at the times of waste-loss events using the SIM. For comparison, a BY Tank Farm vadose zone  $^{137}\text{Cs}$  inventory estimate of approximately 30 Ci is provided in Addendum to the BY Tank Farm Report (GJO-HAN-6) September 2000. Thus, the current  $^{137}\text{Cs}$  inventory estimate is considerably more conservative than that provided in the BY Tank Farm Report.

### 3.3.3 Single-Shell Tank 241-C-111

The leak volume estimate for SST C-111 was decreased from 5,500 gal (HNF-EP-0182) to zero. The previous estimate was stated as being based on an observed liquid-level decrease, but the basis for the liquid level decrease is not well documented. A 1981 tank integrity assessment documented a then unexplained 8.5 inch liquid level decline in SST C-111 observed between October 1965 and December 1969 (approximately 39 months), which corresponds to ~23,000 gal. (RHO-CD-1193). The 1981 tank integrity assessment team thought the supernate in SST C-111 was mostly process condensate from the 201-C Strontium Semiworks and the maximum tank waste temperature was less than 100°F.

However, a recent investigation of historical process information indicates the supernate in SST C-111 was mostly process waste from the 201-C Strontium Semiworks that contained  $^{144}\text{Ce}$  (RPP-ENV-33418 section 4.3). Furthermore, after SST C-111 received the 201-C Strontium Semiworks waste during the second quarter of 1964, temperature records show that the tank heated up to greater than 190°F (RHO-CD-1172, pages B-61 and B-62). The high temperature suggests that the observed decrease in surface level can be explained by evaporation.

$^{144}\text{Ce}$  is a radionuclide that was separated from  $^{90}\text{Sr}$  during processing conducted at the 201-C Strontium Semiworks. The half-life of  $^{144}\text{Ce}$  is approximately 284 days, with the decay of  $^{144}\text{Ce}$  (and daughter  $^{144}\text{Pm}$ ) generating ~0.008 watts per curie. The radioactive decay of the  $^{144}\text{Ce}$  present in SST C-111 was sufficient to cause the evaporation of water, as evident by the reported tank waste temperature of 190°F in 1964. Evaporation of water from SST C-111 was shown to be the sole cause for the 8.5 inch liquid level decline observed between October 1965 and December 1969. The evaporation of water from SST C-111 was also shown to correspond with the radionuclide decay rate for the inventory of  $^{144}\text{Ce}$  present in SST C-111. When the inventory of  $^{144}\text{Ce}$  present in SST C-111 had decayed to a negligible quantity, the evaporation of water was also shown to have stopped (RPP-ENV-33418 section 4.3.3).

Further supporting that SST C-111 did not leak waste to the vadose zone is the lack of activity present in drywells surrounding this tank. Minor surface level contamination and less than 1 picocuries of  $^{137}\text{Cs}$  per gram of soil was detected at depth in these drywells when gamma spectral logging was conducted between 1997 and 2000 (GJPO-HAN-18, 1998 and GJO-98-39-TARA, 2000).

Based on this information, SST C-111 did not leak any waste and the estimated leak volume in Table 2-2 has been adjusted accordingly.

### 3.3.4 Single-Shell Tank 241-SX-110

The estimated leak volume for SST SX-110 was reduced from 5,500 gal to a nominal 1,000 gal. SST SX-110 was classified as an assumed leaker in 1976 with a leak volume of 5,500 gal based on a 2-in. liquid-level decrease (HNF-EP-0182).

Waste status summary reports for 1971 through 1976 and WHC-MR-0132 show that the tank contained a sludge heel of REDOX HLW at the time of the leak. From fourth quarter 1975 through second quarter 1976, SST SX-110 received a variety of waste from 200 East Area tanks (B-103, BX-103, BX-105, and 241-302B catch tank). In 1975 through 1976, miscellaneous supernatants were consolidated in these tanks and then transferred to SST SX-110 for staging as feed to the 242-S Evaporator. The waste was identified as a mixture of waste types including ion-exchange waste (cesium depleted waste from the B Plant ion-exchange process), 224 waste (lanthanum fluoride finishing waste), evaporator bottoms, REDOX HLW sludge, and waste from the 300 Area laboratory. There also was likely PUREX coating removal waste and N Reactor decontamination waste mixed in with other waste types given the various transfers and collecting supernatants from numerous tanks in SSTs B-103, BX-103, and BX-105 for transfer to SST SX-110. In the third quarter of 1976, the integrity of SST SX-110 was suspected, and all pumpable supernatant was removed.

A 1,000-gal loss of this waste type mixture would result in high levels of radioactivity in tank laterals (HNF-5782). However, little or no activity was found in the spectral gamma logging drywell data (GJPO-HAN-4) or in gross gamma logging data from the laterals 10 ft below the bottom of the tank (HNF-5782).

The 5,500-gal leak volume estimate for SST SX-110 appears to be based on a 2-in. decrease in the tank liquid-level manual tape measurements observed between August 23, 1974, and September 24, 1974. A comprehensive review of the liquid-level decrease was conducted in 1980 (RHO-CD-896). The 1980 study notes that three occurrence reports concerning SST SX-110 were issued. One for a 1-in. liquid-level decrease in September 1974 following a transfer completed August 23, 1974, which exceeded the leak detection criterion of 1.5 in./wk. The second in January 1975 for a rise of radiation levels at the 53 to 57 ft level in drywells 41-10-08 and 41-11-03. The third for a 0.75-in. liquid-level decrease in seven days observed June 1976. All of these occurrence reports concluded that SST SX-110 was a "sound" tank. However, questions continued regarding the status and it was designated questionable integrity.

Three groups evaluated available information independently: (1) a tank farm surveillance group, (2) Tank Farm process control group, and (3) effluent controls group to determine if SST SX-110 should be classified a confirmed leaker. Following an initial review, all three groups recommended that the tank continue to be classified as questionable integrity. At a 95% confidence level, only the Tank Farm surveillance group recommended reclassifying the tank as a confirmed leaker concluding "the tank did leak during 1974 at a high-liquid level, likely above the 340-in. Level." However, the groups also stated that "the level additions exceeding the 340-in. level and the apparent psychometric liquid-level decreases (i.e., evaporation) could have masked a tank leak." It was noted that the last evaporative water from SST SX-110 was reported in April-June 1966 (ISO-404, *Chemical Processing Division Waste Status Summary April 1, 1966 Through June 30, 1966*). No evaporative water losses are reported for this tank after June 1966 (see ISO-538, *Chemical Processing Division Waste Status Summary July 1, 1966 Through September 30, 1966*; ISO-674, *Chemical Processing Division Waste Status Summary October 1, 1966 Through December 31, 1966*; ISO-806, *Chemical Processing Division Waste Status Summary January 1, 1967 Through March 31, 1967*; ISO-967, *Chemical Processing Division Waste Status Summary April 1, 1967 Through June 30, 1967*).

None the less, the chief scientist concluded that: “.. alone the liquid level decreases would normally be strong evidence that Tank 110-SX is a leaker, but there appears to be little, if any, dry well or lateral monitoring information to support the hypothesis that Tank 110-SX is indeed a leaker. In fact, all lateral and/or dry well readings can be accounted for by other means. Furthermore, a perfectly rational and acceptable explanation for liquid level decreases noted in August-September 1974 and in 1976 is to be found in the high heat content of the sludge in Tank 110-SX and resulting evaporation losses through the sludge cooling system”.

The purpose of this report is to provide a reasonable leak volume estimate for tank performance assessments. Based on lateral measurements directly under the tank and results presented in the 1980 study, an estimate of 5,500 gal, which would attribute the entire liquid-level decrease to a tank leak, is not reasonable. An estimate of “0” leak also cannot be proven. Therefore, pending additional characterization data, a nominal leak volume of 1,000 gal was assumed.

### 3.3.5 Single-Shell Tank 241-SX-112

The estimated leak volume for SST SX-112 was reduced from 30,000 gal to a nominal 1,000 gal. SST SX-112 was classified as an assumed leaker in 1976 with a leak date of 1969 and a leak volume of 30,000 gal (HNF-EP-0182).

SST SX-112 was used to store REDOX boiling waste. This tank was first filled with REDOX HLW in 1956; most liquids were removed in 1960, and then refilled with REDOX HLW. Again, most liquids were removed in 1966 and the tank again received REDOX HLW. Over the time period from 1956 till 1969, many hundreds of thousands of gallons of water were lost from this tank through evaporative cooling and replaced with water or stored REDOX condensate. Finally, in the first quarter of 1969, 498,000 gal of aged REDOX HLW was removed from this tank. Also shown in the waste transfer records (LA-UR-97-311) are two liquid-level decreases, one (32,000 gal) attributed to REDOX condensate loss from evaporative cooling, and the second (31,000 gal) to a potential tank leak. In-tank photographs taken in 1974 show a 3 in.-wide crack in the steel liner 17 ft above the tank base (34 ft bgs) (SD-WM-TI-356) and a bulge in the steel liner (RHO-R-39, *Boiling Waste Tank Farm Operational History*). Thus, it is likely the steel liner was breached sometime during the time REDOX HLW was stored in this tank leading to potential tank leaks.

A 30,000-gal leak of REDOX HLW would be expected to result in the loss of high levels of radioactivity (an estimated 40,000 Ci of  $^{137}\text{Cs}$ ) (HNF-5782; HNF-EP-0182) to the soil column. There are nine drywells drilled close to the edge of this tank and three laterals under the tank that were used as a secondary leak detection system. Spectral gamma logging of drywells around SST SX-112 identified two drywells (41-12-02 and 41-12-03) with peak  $^{137}\text{Cs}$  gamma activities of about  $1.0\text{E}+08$  and  $1.0\text{E}+05$  pCi/g, respectively. However, the peak gamma activity is approximately 20 ft below the base of SST SX-112. Based on gamma activity of other drywells in this area, the  $^{137}\text{Cs}$  activity found in these two drywells (41-12-02 and 41-12-03) is believed to have originated from the SST SX-108 leak events (RPP-7884).



Only one of three laterals (lateral 44-12-02) under SST SX-112 shows gamma activity (SD-WM-TI-356; GJ-HAN-14). The location of this gamma activity is consistent with a tank leak; however, the gamma activity is significantly lower than would be expected for a 30,000-gal leak of REDOX HLW. A 30,000-gal leak involving REDOX HLW would have left a  $^{137}\text{Cs}$  activity "footprint" similar to that found around SSTs SX-107 and SX-108 (RPP-7884). Thus, the gamma logging data around and under SST SX-112 is inconsistent with the "1969 leak event scenario."

Following is a more detailed discussion of the waste transfer records for SST SX-112 that suggest a reason for apparent inconsistency between gamma logging measurements and the 1969 leak event scenario. The waste data summary records show that from January through June 1966, no boil-down or tank waste evaporation was observed (ISO-226, *Chemical Processing Division Waste Status Summary January 1, 1966 Through March 31, 1966*; ISO-404). Between July and September 1966, the tank received 292,000 gal of REDOX waste from 202-S (ISO-538) also from July through September 1966, 220,000 gal of boil down occurred (ISO-538). From October through December, another 35,000 gal of boil-down is reported (ISO-674). Also, during the fourth quarter of 1966, the tank received 65,000 gal of supernatant and 300,000 gal of water (ISO-674). The added water accounts for more than one-half the waste volume in the tank at that point in time. Following this transfer, "0" boil down was reported up to December 1967, after which boil down was not recorded in the waste status summaries. No additional waste was added to or transferred from SST SX-102 until the fourth quarter of 1966 when 21,000 gal of supernatant from SST SX-107 was added.

Transfer records (LA-UR-97-311) appear to be inconsistent with the waste status summaries, showing a REDOX condensate loss of 335 kgal in fourth quarter 1966, but no reference or basis for this is presented.

The liquid level decrease was observed just after the SST SX-107 transfer. The level of waste in the tank prior to the water transfer was 596 kgal (222 in.). This is just above the level of the liner crack (204 in.). Therefore, the previously estimated 30,000-gal leak may have been mostly water with some SST SX-107 supernatant and little or no REDOX supernatant.

The portion of water versus waste leaked and activity associated with the waste leaked is unknown other than the levels of activity observed in the vadose zone. However, the activity level measured in the vadose zone is well below what would be expected if even a one-thousand gallon leak of REDOX Supernatant occurred. Therefore, a nominal leak volume of 1,000 gal of REDOX supernatant was assumed to estimate contaminant inventories.

### 3.3.6 Single-Shell Tank 241-U-101

The leak volume estimate for SST U-101 was reduced from 30,000 gal to 5,000 gal of REDOX liquid waste. SST U-101 was removed from service as a confirmed leaker in 1959 (HNF-EP-0182, SD-WM-TI-356). However, no information could be found documenting a leak event or occurrence report for the tank. Tank transfer records show unexplained liquid-level decreases from a level of 540,000 to 516,000 gal in the tank between the second quarter of 1958 and the second quarter of 1960 before liquids were removed leaving 26,000 gal of solids.

However, the four drywells within 15 to 18 ft of SST U-101 (60-00-02, 60-01-08, 60-01-10, and 60-04-12) show minimal surface contamination from 0 to 20 ft belowgrade ( $< 10$  pCi/g) activity, but no elevated activity was found below 20 ft (GJ-HAN-33).

An analysis of the heat load generated by the waste in SST U-101 at the time of the liquid losses would support assigning some losses to "evaporative cooling" (RPP-15808). Metal waste was emptied from SST U-101 in 1957 and then refilled in 1958 with REDOX (R1) HLW supernatant transferred from SST SX-103. However, the R1 supernatant stored in SST SX-103 was not identified in any of the Tank Farm Waste Status Summary Reports as being self concentrating or boiling waste. SST SX-103 process records show a steady waste volume of 943,000 to 941,000 gal between August 1955 and April 1958, indicating that there was little evaporation in the waste transferred.

Because little leak information was found and drywell data are inconsistent with a 30,000 gal leak, an estimate of the maximum leak volume that could go undetected in drywells near tank U-101 was applied. The maximum leak volume for tank U-101 is estimated to be 5,000 gal based on an evaluation of data collected at the Sisson and Lu field test site (RHO-ST-46P, *Field Calibration of Computer Models for Application of Buried Liquid Discharges: A Status Report*) and complemented by the T-106 leak (RHO-ST-14).

Further characterization of SST U-101 is planned.

### 3.4 GROUP 4 TANKS

Group 4 consists of 18 tanks (AX-104, B-101, B-103, B-105, B-111, BX-110, BX-111, BY-105, BY-106, SX-114, T-107, TX-105, TX-110, TX-113, TX-114, TX-115, TX-116, and TX-117). Little information is available for these tanks to support a leak volume estimate, and no previous leak inventory estimate has been developed. Also, no leak volume estimate has been developed for these tanks other than to assume an average value based on previous tank leaks from 18 other tanks (8901832B, "Single-Shell Tank Leak Volumes"). The average leak volume estimate in HNF-EP-0182 for these tanks was based on an assumption that their cumulative leakage is approximately the same as for 18 of the 24 tanks where leak volumes were determined by liquid-level decreases. SSTs SX-110 and T-106 were considered atypical and were not included. SSTs B-201, -203, -204, and C-203, also excluded, are small 200-series diameter tanks. The 18 tank leak estimates that were included in the estimate were SSTs A-103, AX-102, B-107, B-110, BY-107, C-101, C-111, S-104, SX-104, SX-109, T-103, T-108, T-109, T-111, TY-101, TY-104, U-110, and U-112 (8901832B). The total liquid-loss assumed for the 19 tanks was 150,000 gal, an average of approximately 8,000 gal/tank.

However, for these tanks, small levels of contamination (much smaller than plumes for typical tank leaks; tanks in Group 1) were observed in nearby drywells. Drywell measurements for these tanks are presented in the DOE Grand Junction reports (Table 2-1).

The contamination for tanks in Group 4 may have come from a tank or from near-surface releases or other sources. Therefore, neither the waste type and source of the drywell activity nor the date when it occurred are known; all of which are needed to determine a credible inventory

estimate. A key distinction between these 18 tanks and tanks in Group 3 is that unexplained liquid-level decreases were observed for tanks listed in Group 3, but no unexplained liquid-level decreases were observed for the 18 tanks in Group 4. The only indication of contamination and the basis for classifying the tanks as "questionable leakers" were gamma monitoring results found in drywells near the tanks.

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#### 4.0 NEAR-SURFACE CONTAMINATION IN THE SINGLE-SHELL TANK FARMS

As part of the Tank Farms vadose zone characterization efforts, a series of documents were prepared that examine the operational history of each of the SST farms:

- HNF-5231, *Historical Vadose Zone Contamination from B, BX, and BY Tank Farm Operations*
- RPP-5957, *Historical Vadose Zone Contamination from T, TX, and TY Tank Farm Operations*
- RPP-7494, *Historical Vadose Zone Contamination from A, AX, and C Tank Farm Operations*
- RPP-7580, *Historical Vadose Zone Contamination from U Farm Operations*
- HNF-SD-WM-ER-560, *Historical Vadose Zone Contamination from S and SC Tank Farm Operations*.

These documents, prepared by Fluor Federal Services, provide an overview of the structural aspects of the Tank Farm operations such as waste transfer piping systems and infrastructure. These documents also provide a compilation of the UPRs within the tank farm or WMA of concern. Another document reviewed to assess near surface contamination in the Tank Farms was the Handbook for 200 Area Waste Sites (RHO-CD-673). Each of the identified UPRs has a formal report associated with it that is retrievable over the Hanford Intranet from WIDS. Table 4-1 shows UPRs applicable to SST farm WMAs based on data in WIDS as of July 1, 2005. A second UPR number was assigned to group UPRs by tank farm or WMA. Table 4-1 does not include UPRs associated with the tank leaks previously identified in Table 2-2.

It was assumed that little or no soil contamination inventory is associated with UPRs identified as "airborne" or "particulate," and these are not included in the SIM. Volume estimates for each of the UPRs are those specified in WIDS, except as noted, where WIDS did not provide an estimate. For these, the volume estimates and basis used were based on assumptions in Table 4-1. As shown in Table 4-1, volume estimates were not provided for UPRs assumed to be small, the result of particulate, or where there was no technical basis for a volume estimate.

Future near-surface characterization efforts are scheduled for a number of the SST farms. However, as currently scoped, these efforts will only address selected near-surface waste-loss events. General characterization to better quantify near-surface contamination within a tank farm would require a much-expanded effort. The list of UPRs in Tank Farm areas may also change as WMAs are further defined and as ongoing Hanford Site integration studies are completed.

Table 4-1. Waste Management Area UPRs. (3 sheets)

UPR	Consolidated UPR <sup>1</sup>	In SIM	Waste type	Date	Volume* (gal)	Location/Comments
UPR-200-E-4	200-E-120 B-Farm	No	Cooling Water	1951	No Basis	241-B-151 diversion box UPR. Contamination removed.
UPR-200-E-6	200-E-120 B-Farm	Yes	1C2	1954	1017	241-B-153 diversion box, Volume estimate for 1 Ci of 1C waste over 5,000 ft <sup>2</sup> . Volume assumes 1 in. depth and 0.33 soil void.
UPR-200-E-16	200-E-133 C-Farm	No	CWP	1952	50	Release occurred northeast of the C-105 pump pit
UPR-200-E-27	200-E-133 C-Farm	No	Particulate	1960	N/A	244-CR, inside tank farm fence, windblown contamination.
UPR-200-E-38	200-E-120 B-Farm	Yes	P2-CSR	1968	5,400	241-B-152 diversion box release. Volume from WIDS.
UPR-200-E-47	200-E-131 A-Farm	No	Particulate	1974	N/A	A Tank Farm contamination spread, failed HEPA filter 702-A
UPR-200-E-48	200-E-131 A-Farm	No	Particulate	1974	N/A	A-106 pump pit, windblown contamination.
200-E-60	Not a UPR	Yes	DW	1977	1,370	BY Tank Farm inactive miscellaneous underground storage tank (IMUST). Volume estimate assumes 1/3 of the vessel volume or 1,370 gal leaked during decontamination.
UPR-200-E-68	200-E-133 C-Farm	No	Particulate	1985	N/A	241-C-151 diversion box, wind blown contamination; RPP-RPT-29191 page 113
UPR-200-E-73	200-E-120 B-Farm	Yes	MW2	1951	92.5	241-B-151 diversion box release, ~10 Ci, most removed then covered. Volume for 10 Ci, MW.
UPR-200-E-74	200-E-120 B-Farm	Yes	Decon Waste	1954	10 gal	241-B-152 diversion box, 1 Ci spread 50 ft <sup>2</sup> . Localized to personnel. Volume based on 1 Ci Decon Waste.
UPR-200-E-75	200-E-120 B-Farm	Yes	1C2	1955	1017	B-153 diversion box, ~1 Ci released over 5,000 ft <sup>2</sup> . Volume based on 1 Ci of 1C waste, and assumes 1 in. depth and 0.33 void.
UPR-200-E-81	200-E-133 C-Farm	Yes	CWP	1969	36,000	CR-151 diversion box. WIDS Volume.
UPR-200-E-82	200-E-133 C-Farm	Yes	P2-CSR	1982	2,600	241-C-152 diversion box. WIDS Volume.
UPR-200-E-86		Yes	PSS	1971	18,500	C Tank Farm line break, 6m x 6m contamination. Volume based on 25,000 Ci <sup>137</sup> Cs, 1.35 Ci/gal.
UPR-200-E-105	200-E-132	Yes	1C2	1952	23,000	BY-107 manifold header.

Table 4-1. Waste Management Area UPRs. (3 sheets)

UPR	Consolidated UPR <sup>1</sup>	In SIM	Waste type	Date	Volume* (gal)	Location/Comments
	BX/BY-Farm					WIDS volume.
UPR-200-E-107	200-E-133 C-Farm	Yes	TBP-UR	1952	5	Contamination spread to ground during transfer pump installation in SST-110. WIDS volume.
UPR-200-E-108	200-E-120 B-Farm	Yes	MW2	1953	196	B-102 to B-101 transfer line small spill, but visible. Volume calculated based on 10 rad/h, 10 ft radius, assumes 1 in. depth and 0.33 void.
UPR-200-E-109	200-E-120 B-Farm	Yes	TBP-UR	1953	150	B-104 pump float jam, riser spill. WIDS volume.
UPR-200-E-110	200-E-132 BX/BY-Farm	Yes	1C2	1955	5,086	BY-112 valve pit release, Volume based on 25,000 ft <sup>2</sup> (WIDS) assumes 1 in. depth and 0.33 void.
UPR-200-E-115	200-E-131 A-Farm	No	PUREX	1974	No Basis	AX-103 pump pit spray, small volume on employee and ground.
UPR-200-E-116	200-E-132 BX/BY-Farm	No	BY Salt	1972	No Basis	BY-112 pump pit caustic flush water, 3 rad/h Sr and Cs.
UPR-200-E-118	200-E-133 C-Farm	No	Particulate	1957	N/A	C-107 airborne tank release caused ground contamination
UPR-200-E-119	200-E-131 A-Farm	No	P2-AR	1969	0.03	AX-104 surface contamination, contaminated tools set on ground.
UPR-200-E-145	200-E-131 A-Farm	Yes	P3	1993	1650	Pipeline leak, east of A Tank Farm entrance, 3m x 6m. WIDS Volume for 30 55-gal drums.
UPR-200-W-12	200-W-94 TX/TY-Farm	Yes	1C Evap	1951	5	Riser leak S of 242-T, inside T Tank Farm. WIDS states "a few gallons", assume 5 average and 10 max.
UPR-200-W-17	200-W-94 TX/TY-Farm	No	1C	1952	No basis	Not enough information for a volume estimate. Appears negligible.
UPR-200-W-24	200-W-95 U-Farm	Yes	MW1	1953	36	244-UR vault release. One in. diameter column 30 ft high for 30 seconds (WIDS). Volume estimate assumes one column volume is replaced every second for 30 seconds.
UPR-200-W-49	200-W-96 S/SX/SY-Farm	No	Particulate	1958	N/A	Windborne particulate from SX Tank Farm.
UPR-200-W-50	200-W-96 S/SX/SY-Farm	No	Particulate	1958	N/A	Windborne particulate from SX Tank Farm.

Table 4-1. Waste Management Area UPRs. (3 sheets)

UPR	Consolidated UPR <sup>1</sup>	In SIM	Waste type	Date	Volume* (gal)	Location/Comments
UPR-200-W-80	200-W-96 S/SX/SY-Farm	No	Particulate	1978	N/A	S/SX tank farms windborne.
UPR-200-W-81	200-W-96 S/SX/SY-Farm	No	Particulate	1973	N/A	Radioactive specs in S/SX tank farms from contaminated equipment
UPR-200-W-100	200-W-94 TX/TY-Farm	Yes	1C2	1954	2,543	Inside TX Tank Farm, TX-105 to TX-118 line leak. WIDS states ~10 Ci. 12,500 ft <sup>2</sup> covered. Volume assumes 1 in. depth and 0.33 void.
UPR-200-W-126	200-W-94 TX/TY-Farm	No	Particulate	1975	N/A	241-TX-153 airborne. Employee contaminated
UPR-200-W-127	200-W-96 S/SX/SY-Farm	Yes	R2	1980	87	Liquid pool from 242-S Evaporator inside S Tank Farm fence. Volume assumes a 1 m <sup>3</sup> pool with a 0.33 void.
UPR-200-W-128	200-W-95 U-Farm	No	R1	1971	No Basis	U-103 tank pit waste line, employees cut it and were contaminated.
UPR-200-W-129	200-W-94 TX/TY-Farm	No	1C1	1971	No Basis	TX Tank Farm pump pit personnel contamination
UPR-200-W-132	200-W-9 U-Farm	Yes	MW2	1956	500	241-UR-151 diversion box release. WIDS volume.

Notes:

\* WIDS volume estimates are as of March 1, 2005.

1. Consolidated UPRs:

200-E-120 Contamination Migration from 241-B Tank Farm,

200-E-131 Contaminated Soil Associated with 241-A Tank Farm,

200-E-132 BX/BY Tank Farm Contaminated Soil, 200-E-133 Contaminated Soil at C Tank Farm,

200-E-134 Contaminated Soil at 241-AW Tank Farm,

200-W-93 Contaminated Soil at 241-T Tank Farm,

200-W-94 Contaminated Soil at TX/TY Tank farm,

200-W-95 Contaminated Soil at U-Tank Farm,

200-W-96 Contaminated Soil at 241-S/SX/SY Tank Farm.

1C1 = first cycle decontamination waste from the BiPO<sub>4</sub> process, 1944 to 1951.1C2 = first cycle decontamination waste from the BiPO<sub>4</sub> process, 1952 to 1956.

AR = washed PUREX Sludge

CSR = cesium recovery.

CWP = cladding waste, PUREX.

DW = decontamination Waste

HEPA = high-efficiency particulate air (filter).

MW1 = metal waste from BiPO<sub>4</sub>, 1944 to 1951MW2 = metal waste from BiPO<sub>4</sub>, 1952 to 1956.

N/A = not applicable.

P2 = PUREX high-level waste, 1963 to 1967

P3 = PUREX high-level waste to AZ-101

PUREX = plutonium/uranium extraction.

PSS = PUREX sludge supernate

R1 = REDOX waste, 1952 to 1957

R2 = REDOX waste, 1958 to 1966

SIM = Soil Inventory Model.



Table 4-1. Waste Management Area UPRs. (3 sheets)

UPR	Consolidated UPR <sup>1</sup>	In SIM	Waste type	Date	Volume* (gal)	Location/Comments
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TBP = tributyl phosphate.

UR = Uranium Recovery

UPR = unplanned release.

WIDS = *Waste Information Data System.*

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